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During periods of freight car shortage demands are so insistent that it becomes the first duty of all concerned to do everything possible to assist in improving the utilization of the existing rolling stock. The incentive is a real one when it is remembered that at such times a car not used represents an average revenue loss of about $6 for each idle day. It is a startling fact that freight cars spend about 20 per cent of their time on repair tracks or in traveling to and from such tracks. This is the point where the attention of the mechanical departments of the railroads must be concentrated if they are to do their share toward improving conditions. As a car leaving the repair track means one more car available for traffic, at times of urgent demand for cars there is a strong temptation to do just enough work to turn a car back into service again. The general car situation has been but little improved, however, if at an early date that same car is obliged to make another trip to a repair track and has to be again withdrawn from service for another day or so, as is usually the case even though the work may be performed in an hour or two. When the need for cars is the greatest is the time when the fullest benefit may be obtained by doing a thorough job on every car that reaches the cripple track. Not only should the work that is necessary to repair the parts whose condition caused the withdrawal of the car from service be well done, but in addition the opportunity should be utilized to repair all other parts which careful inspection shows might require attention at an early date. It is not so much the number of cars which are turned out that really counts as the number of cars which are in a condition to stay out in service and continue to earn revenue.

Make the Repair Job a Thorough One

There seems to be a general impression among railway operating men that modern locomotives do not give as high power output in proportion to their weight nor haul as heavy loads as locomotives in use some years ago. Investigation often shows that the available power of large locomotives is not being fully used and very often trial runs show very much better performance than is attained in everyday service. A comparison of locomotive tractive force with train resistance in most cases would indicate that heavier loads could be hauled or higher speeds made than seems possible in practice. Probably the reason that a large locomotive does not come up to expectations, even when in good condition from a mechanical standpoint, lies in the fact that it is supplied with a limited amount of fuel, often very much less than it has been designed to burn. The general proportions of locomotives are usually based on the assumption that 120 lb. of coal will be burnt per hour for each square foot of grate area. Typical modern Mikado or Pacific type locomotives usually have from 60 to 70 square feet of grate and would, therefore, require 7,200 to 8,400 lb. of coal an hour. The limit of hand firing is about 7,500 lb. an hour but the best that can be expected from the average fireman is about 6,000 lb. It is natural for the fireman to spare himself as much as possible and in every-day service the rate of firing will usually not exceed 3,000 to 4,000 lb. of coal per hour while a locomotive is running. This means that the firebox is getting less than half the amount of coal it can use and the cylinders are getting only about half the amount of steam they were designed for.

Utilizing Capacity of Locomotives

Under these conditions it would be possible to increase the power of the locomotive at a speed where the boiler is the limiting factor by as much as 40 per cent by merely increasing the fuel supply. There is a big opportunity for improving operating performance by starting a campaign among the firemen to get them to supply somewhere near the amount of coal a locomotive is intended to burn. If this cannot be done there does not seem to be any excuse for building such large hand-fired locomotives. If the locomotive was designed for the limited amount of coal which the firemen will shovel, it could be made smaller, cheaper and be easier to maintain. There is another alternative, of course, the application of mechanical stokers on all large locomotives. It is generally accepted that the application of a stoker is justified on locomotives requiring over 6,000 lb. of coal an hour. Many locomotives that far exceed these limits are still being built for hand firing. There seems little justification for providing excess capacity unless it can be utilized and the application of stokers on all large locomotives would seem to be absolutely necessary for efficient operation.

There is no doubt that many practical railroad shop men object to schedule systems because of the clerical work involved in filling out certain forms. They fail to realize that shop schedules, to be of practical value, must consist of something far more vital than assigning a clerk to fill out forms regarding work already done. The effective shop schedule orders work and material in advance, and is an important aid in locating weak departments, speeding up operations and increasing shop output. The schedule system has already demonstrated its ability to perform these functions, and the number of forms used can be suited to the needs of individual shops. The schedule system installed at the Jackson shops of the Michigan Central, as described in this issue, has few printed forms, and yet its effective control of shop operations was one of the important factors enabling the Jackson shops to recover quickly from the strike and in a period of three months show an important increase above normal output.

An Effective Schedule at Jackson Shops

The first essential of any successful schedule system is that the entire shop supervision believe in it and work for it. At Jackson, everyone from the division master mechanic and shop superintendent down to the youngest foreman is apparently an enthusiastic booster for the schedule. The reason is that the schedule system gives these men a reasonably logical method of controlling shop operations. It relieves

them of many minor details, affording opportunity to concentrate on more important features of the work. In addition, it so times the work of the various departments that as a rule locomotive parts arrive at the erecting shop ready for assembling as they are needed.

It is impossible to run a shop schedule system successfully without the services of some man of reasonably high calibre, who is familiar with locomotive repair work, to fill the position of schedule supervisor. At Jackson this man is given the title of schedule foreman and made responsible not only for scheduling locomotives but also for following up work orders, trucking all material through the shops and shipping to outside points. The schedule foreman has an assistant to handle details of the work, a clerk to look out for work orders, and ten laborers provided with power tractors and trailers for moving material. The movement of material is intimately involved in a successful schedule system; knowing when various operations are to be completed, the schedule foreman is in the best position to supervise the movement to the next machine or department. Special attention is directed to the efficient power-trucking system at Jackson shops as described in the article.

Of particular interest also is the efficiency department at Jackson, composed of two machinists, two boiler makers and a blacksmith who, under the close personal direction of the assistant shop supervisor, devote their entire time to tracing delays as indicated by red marks on the schedule board, locating the weak points in various departments and strengthening them. When one department has been brought up to the standard, some other becomes the limiting factor and receives the same kind of attention. In this way there is a gradual toning up of the entire shop organization, with a decidedly favorable effect on shop output.

The Standard Box Car

A circular recently issued by the American Railway Association states that the committee on car construction of the Mechanical Division has practically completed designs for standard box cars of 40 and 50 tons capacity which will be submitted to the roads which are members of the American Railway Association for adoption. The standard car will probably be the most important technical question that will come before the next Mechanical Division meeting. Standard designs for freight cars have often been proposed before but it has not been possible to get the railroads to agree on a satisfactory type. In 1914, the American Railway Association appointed a committee to work out designs for standard box cars. A sub-committee representing the principal carbuilders was appointed and later representatives of the mechanical departments of some of the principal railroads were added to the membership. Three designs were prepared by the sub-committee and sample cars were built in 1917 but a short time later this country entered the war and the matter was not carried through to a conclusion.

When Mr. McAdoo was appointed director general of railroads, he attempted to bring about a standardization of equipment which resulted in the design of the cars built by the Railroad Administration. These were compromise designs hurriedly prepared and no one has ever proposed that they should be perpetuated as a standard of American railroads.

Since the end of federal control the Committee on Car Construction has gradually been laying the foundation for the development of the standard box cars. As a basis for the design, certain fundamental dimensions and minimum strength requirements were proposed in 1920. These were adopted by a letter ballot of the Mechanical Division and approved by the American Railway Association. The designs which the committee is now ready to submit have, no doubt, been worked out with the greatest care. It still remains to be seen whether the railroads will be able to get together on the project on which in the past they have never been able to agree. It is evident that certain advantages could be obtained by a standardization of box cars but there are difficulties in putting the scheme into practice. The standard car would certainly stop the building of inferior designs. It should bring about some reduction in the cost of building cars and should facilitate repairs on foreign lines after a sufficient number have been placed in service to justify the roads in keeping repair parts in stock. There are certain difficulties that are bound to arise from the adoption of a standard car. After the design has once been definitely standardized there will be a tendency to perpetuate it and if this is carried too far it may prevent the adoption of improved types of construction. It will also be difficult to develop a design that will not discriminate against the manufacturers of certain car appliances.

There is some question whether the railroads are ready at this time to adopt a standard car but even if the time is not ripe for a unified design, the roads should go on adopting standard dimensions and minimum requirements that will promote interchangeability of parts and facilitate the repair of cars off the home line.

The Problem of Rebuilding Locomotives

One of the perplexing problems which the railroads have had to face in recent years has been to obtain a well balanced design in rebuilt locomotives without excessive expenditures. Practically all the important modern appliances for increasing the economy of the locomotives are boiler accessories. If the boiler is rebuilt with the addition of one or more of these devices it usually has more capacity than the cylinders can use and as the railroads are anxious to get the maximum tractive force from all their motive power, it is desirable to increase the size of the cylinders. If the cylinder diameter is increased to utilize the available steam capacity, the stresses on the main rods, driving boxes and frames will be too high in most cases. This makes it necessary to provide practically an entire new set of machinery and increases the cost of rebuilding very greatly. Since the introduction of devices for utilizing the trailer or tender wheels to increase the tractive force at low speed, a new method is available for overcoming this difficulty. By applying such devices for increasing the tractive force, the capacity of the boiler at low speed can be utilized. At higher speeds the main cylinders would be able to utilize the full boiler output by running at a slightly longer cutoff. Thus from the engineering standpoint, the introduction of auxiliary devices for increasing tractive force offers new possibilities for obtaining a well balanced design in rebuilt locomotives.

Engine Terminal Machine Equipment

It would be possible, but rather unusual, to overestimate the importance of adequate modern machinery in enginehouses. In most cases the condition is reversed and the needs are underestimated to such an extent that sufficient machine equipment is not available, in proportion to the locomotives despatched, to keep motive power in good operating condition and eliminate delays. Frequently there are no machines at small terminals to perform even comparatively simple operations, such as turning, boring or shaping. As a result, locomotives must be taken out of service and sent to the back shop for slight repairs, or else held in the roundhouse while defective parts are shipped to the main shop, repaired and returned. Revenue is lost while the locomotives are out of service, and unexpected light repair jobs disorganize the schedule work in the back shop.

In enginehouses provided with machine equipment, on the other hand, some of the machines are so old, and were so old when discarded by the back shop, as to be practically useless. Many instances of machinery of this kind, which hinders more than it helps, could be cited, but one will suffice. A prominent eastern railroad purchased a new driving wheel lathe for installation at one of its back shops, the old lathe being shipped to a comparatively new enginehouse and set up. The old lathe was an obsolete model with the driving gear teeth on the face plates exposed, badly worn and having large portions of several of the teeth broken out. In fact, the lathe was in such shape that it could not be used for turning tires at all. It was occasionally used to true journals, but on the whole was more of a liability than an asset, taking valuable space in a congested enginehouse.

The lack of machinery in enginehouses is costly in three ways: Loss of revenue from delayed locomotives, cost of shipping locomotive parts to back shops for repairs, and undue interference with back shop work, increasing its cost. Enginehouse work sent to the back shop is usually marked rush and greatly interferes with the output of the back shop because schedule work must be taken from the machines, the rush enginehouse work substituted and the schedule work then set up again. Where several terminals are located near together and at some distance from the main back shop, experience has shown it a paying investment to equip one of the terminals with a small production machine shop capable of supplying the needs of that district for cylinder packing, valve packing, rod brasses and similar parts. With a few modern machines these parts can be made as accurately and cheaply at the roundhouse as at the back shop. In addition the cost of shipping is saved and the parts are available when needed in a hurry.

Locomotive Maintenance Standards

The ability of a road to handle satisfactorily the volume of traffic offered may at times depend upon the degree of perfection to which the motive power is maintained. A so-called "car shortage" is usually due only in part to an actual lack of cars. Other important contributory causes may be a lack of sufficient terminal facilities or some factors for which the mechanical department is not responsible. The mechanical department is responsible, however, if a sufficient number of the locomotives owned are not maintained in a suitable condition to operate without frequent minor running repairs. A low standard of maintenance makes it difficult to handle full tonnage trains promptly without delays on the road or to turn locomotives as quickly as they should be turned to render the maximum service in relieving traffic congestions. Conditions during recent months have greatly increased the number of locomotives needing general overhauling and the back shops have a big program ahead of them to bring the number of unserviceable locomotives down to a normal figure.

While there undoubtedly is an urgent need for many new locomotives and for a thorough and prompt overhauling of considerable existing power, the need for adherence to a high standard of maintenance and the benefits that can be obtained therefrom should not be overlooked. Even roads that in former years insisted on a relative high state of maintenance have been obliged recently to lower their standards. To such, it may hardly be necessary to call attention to the need of raising the standard as rapidly as possible. The next few months mark what is usually the most trying period of the year at locomotive terminals. Leaky boilers and poor steaming locomotives are indeed a source of trouble in severe weather. Leaky rod packings are dangerous while leaky cylinders and piston packing rings reduce the capacity of the locomotive and have a considerable effect on the fuel consumption. This is also a time of the year when more than the usual attention should be given to the condition of the front end and draft apparatus. Lack of prompt attention to slight defects or wear of mechanical details may not result in immediate and important increases in fuel consumption but if neglected will add considerably to the total eventual cost of repairs. A low standard of maintenance is never economical. Any apparent immediate savings will be far more than equalled by increased bills for fuel and by higher costs of frequent running repairs and general overhaulings.

New Books

SAMPLING AND ANALYSIS OF PIG IRON. *By the Chemists' Committee of the United States Steel Corporation. 40 pages, 6 in. by 9 in., bound in paper. Published by the Carnegie Steel Company, Pittsburgh, Pa.*

This book describes the accepted and approved methods used by the chemists of the constituent companies of the United States Steel Corporation for the sampling and analysis of pig iron, which have been revised to include the latest practices. The work is not only authoritative, but it is also very complete. In addition to methods for determining the more common elements, the determination of titanium and of copper are described.

PRODUCTION GRINDING. *By F. B. Jacobs. 238 pages, 6 in. by 9 in., bound in cloth. Published by the Penton Publishing Company, Cleveland, Ohio.*

This well-arranged and carefully-printed book pertains to production grinding in the industries and contains 188 illustrations. Grinding practices in the automotive field are naturally given the most space, and the use of grinding machines in five prominent American automobile plants, for cutting and finishing repetition machine parts in large quantities, is outlined. Experience in these plants shows that both high production and accuracy can be obtained at the same time with modern grinders, a combination not found to the same degree in any other type of machine tool. While no consideration is given directly to grinding in railroad shops, the book should be read by those interested in more efficient railroad machine shop operation. Many jigs are illustrated, some of which could probably be adapted with slight changes to railroad shop use and a chapter on die grinding will have certain practical applications.

AIR BRAKE ASSOCIATION PROCEEDINGS FOR 1922. *F. M. Nellis, Secretary, 165 Broadway, New York. 232 pages, 6 in. by 9 in. Bound in cloth.*

The twenty-ninth annual convention of the Air Brake Association took place at Atlantic City on June 19, 20 and 21, 1922, only an open meeting of the Executive Committee having been held in 1921. The papers and reports presented included the following: Wastes in Air Brake Service, a paper by Prof. S. W. Dudley; U. C. Equipment, a paper by J. C. McCune of the Manhattan Air Brake Club, and a lantern slide lecture by R. E. Miller; Air Consumption of Locomotive Auxiliary Devices, a final committee report; Triple Valve Repairs, a committee report by the Northwest Air Brake Club, and Recommended Practice, a committee report to which is added a complete copy of recommended practices with the 1922 revisions.

In addition to convention proceedings the Air Brake Association now publishes books on Maintenance of Freight Brakes; Maintenance of Steam Driven Air Compressors; Questions and Answers on No. 6 E. T. Equipment; Handling Passenger and Freight Trains; U. C. Brake Equipment; Code for Testing Air-Operated Auxiliary Locomotive Devices, and Principles and Design of Foundation Brake Rigging.

WHAT OUR READERS THINK

Comments on Designing Gondola Car

CHICAGO, Ill.

TO THE EDITOR:

In the article, "Method Used in Designing C. M. & St. P. Gondola Car," in the November issue of the *Railway Mechanical Engineer,* there appear to be a few arithmetical errors.

Referring to page 641, middle of first column, calculation of moment of inertia of center sill, item "Channels," quantity Ad^2 should read 1.78, not 17.8. This makes $I_z = 1108.546$, $S_t = 148.5$ and $S_b = 142$. Ratio $\frac{US}{ES}$ should read $= \frac{1}{29.4} + \frac{2.05}{142} = .048$.

Calculation near bottom of second column, page 641, should read

$$\frac{250.000}{29.4} + \frac{250,000 \times 2.05}{142} = 12,120 \text{ lb. per sq. in.}$$

Under heading "Body Bolster," page 642, second column, item reading "I_z of webs ———," the third quantity, 14.75, should be cubed, not squared. The summation is correct, however. Line below giving Ad^2 of flanges $0.75 \times 7.5^2 \times 4 = 169$, not 42.2. Sum of $Ad^2 = 1162$ and I_z total $= 1296.35$, instead of 1169.54 making $S_m = 159.5$. With this section modulus stress will become 10,000 lb. per sq. in. very near.

On page 643, "Side Truss," last item of p_4 should be

$$\left(\frac{1}{4} \times p_1\right) \text{not} \left(\frac{1}{4} + p_1\right)$$

while developing a large horsepower when running fast.

In calculating stresses in the diagonals a "straight line" strut formula is used when $\frac{l}{r}$ is as high as 178. The writer believes this formula should not be used when $\frac{l}{r}$ exceeds 120. However, your correspondent has apparently taken l as actual length instead of "equivalent length" which would be one-half actual length when ends are fixed. His intention is apparently to cover this factor by limiting stress to 14,000 lb. per sq. in. It is doubtful whether the method taken gives fair values of the stresses. Certainly member D.E. showing such a wide difference of 3,900 lb. per sq. in. "allowable" and 13,700 lb. per sq. in. "actual" should hardly be passed without further investigation by one of the more exact strut formulas.

The same remark applies to the top chord. The calculation of bending moment due to outward pressure of load is not given, but the writer would be inclined to doubt that a stress of 20,000 lb. per sq. in. on top angle is reduced to 7,630 lb. per sq. in. by the mere application of a wood plank in its weakest direction for bending. The resultant pressure on the side of the car acting at two-thirds the depth from the top can be shown to be

$$P = \frac{1}{2} w D^2 \tan^2 \left(45 - \frac{1}{2} b\right)$$

where w = weight of material per cubic foot (sand = 100 lb.)
D = total depth of load (say 5 ft. 0 in.)
b = angle of repose of material (sand 40 deg.)

Placing in the appropriate values, we find $P = 272$ lb. Therefore, reaction at top angle $= \frac{272}{3} = 91$ lb. per linear foot of car side. Added to this we have a pressure due to centrifugal force when passing around curves at high speed. Assuming an 8-deg. curve and a speed of 40 m.p.h., the well-known formula for centrifugal force gives a pressure of 15.1 lb. per sq. ft., or 75.5 lb. per linear foot of car side. This load is evenly distributed; therefore, reaction at top angle $= \frac{75.5}{2} = 37.75$ lb.

Total reaction at top angle $= 37.75 + 91 = 128.75$ lb. Bending moment taken over 15 ft. length.

$$M = \frac{128.75 \times 15 \times 15 \times 12}{12} = 29,000 \text{ in.-lb.}$$

It now remains to distribute the stress created by this bending moment between the wood and steel. The deflection produced is obviously the same for both members and is in general cases expressed by

$$d = \frac{Wl^3}{nEI}$$

where d = deflection in inches.
W = total load in pounds.
l = length of beam in inches.
E = modulus of elasticity.
I = moment of inertia of section.
n = factor depending upon method of loading and support.

The deflection for the wood may be written $d_w = \frac{W_w l^3}{nE_w I_w}$

and for the steel $d_s = \frac{W_s l^3}{nE_s I_s}$

and from conditions $\frac{W_w l^3}{nE_w I_w} = \frac{W_s l^3}{nE_s I_s}$

l^3 and n are common to both and may be omitted giving $\frac{W_w}{E_w I_w} = \frac{W_s}{E_s I_s}$

Taking $E_w = 1,700,000$ lb. per sq. in. for LL yellow pine
$E_s = 27,000,000$ lb. per sq. in. for steel
$I_w = 9.48$
$E_s = 4.05$
we obtain $6.78\ W_w = W_s$

That is to say the total load W is shared between the wood and steel in the ratio of 1 to 6.78. Seeing that the bending moments taken by the wood and steel are proportional to the loads, we can say that the wood takes

$$\frac{29,000}{1 + 6.78} = 3,720 \text{ in.-lb.}$$

and the steel $= 3,720 \times 6.78 = 25,280$ in.-lb.
Section modulus of the wood $= 7.97$
Section modulus of the steel $= 1.56$

Therefore, stress on wood $= 467$ lb. per sq. in. and on the steel $= 16,200$ lb. per sq. in.

The angle also carries a thrust of 36,600 lb. as a truss member tending to buckle it in same direction as side loading.

The bending moment of 25,280 in.-lb. on the angle is equivalent to an end thrust T multiplied by the deflection.

If, therefore, the deflection due to side pressure is calculated, and also the equivalent end thrust, to which is added the thrust of the truss framing, the section may be treated as a column with the new loading.

$$\text{Deflection in this case} = \frac{Wl^3}{EI} \times \frac{5}{384}$$

$$d = \frac{1{,}930 \times 180^3}{27{,}000{,}000 \times 4.05} \times \frac{5}{384} = 1.34 \text{ in.}$$

$$\text{End thrust} = \frac{25{,}280}{1.34} = 18{,}900 \text{ lb. to be added to } 36{,}600,$$

making 55,500 lb. Using strut formula, allowable stress $= 16{,}000 - 70\,\frac{l}{r}$

$$f_a = 16{,}000 - 70 \times \frac{15 \times 12}{2 \times 1.01}$$

$$= 9{,}700 \text{ per sq. in.}$$

Area = 4 sq. in. Therefore, allowable load = 38,800 lb. Actual load = 55,500 lb.

This would seem to show that the top angle is rather highly stressed, but this maximum would only occur when car, loaded with perhaps the heaviest type of material (sand), passes around a curve at high speed. Also the side posts have some influence in supporting the 15-ft. length of angle and therefore the above calculated bending moment may be higher than would actually occur. For these reasons the section 5 in. by 3½ in. by ½ in. angle is probably about right, although 5 in. by 5 in. might be better.

The large number of cars with badly bulging sides that are to be seen in service is sufficient evidence of the importance of obtaining the best possible design of side construction.

H. J. COVENTRY.

NOTE—Slide rule was used in all calculations.

Note: In addition to the points mentioned above, attention is called to the fact that in the table on page 641 giving the meaning of the symbols, the items S_b and S_t should be transposed.

Advantages of Three-Cylinder Locomotives

ASHFORD, KENT, ENGLAND.

TO THE EDITOR:

As one who has made a close study of three-cylinder locomotives during the past 15 years, I have read with the greatest interest the article in the November issue of the *Railway Mechanical Engineer* dealing with the Characteristics of Three-Cylinder Locomotives. The conclusions arrived at exactly agree with those given in a paper which the writer read before the Institution of Locomotive Engineers (London) in 1918.

While Mr. Meineke has made out a good case for the use of three cylinders, there are yet other advantages which he has not touched upon. For instance, the reciprocating masses of each set of parts are only about 70 per cent of a corresponding two-cylinder engine, and further, it is sufficient to balance, say 50 per cent, instead of 66 per cent. The balance weights are therefore much lighter, and not only so, but their positions are such that the weights on the right and left-hand sides are about 180 deg. apart. As a consequence, there is little or no variation in adhesion when running fast, because when one weight tends to lift the left-hand wheel, that on the right-hand side acts downwards. In the two-cylinder engine the weights are 90 deg. apart and their combined effect is to alternately augment and diminish the adhesion of the pair of wheels. This variation in adhesion in conjunction with the more irregular turning moment makes the two-cylinder engine more liable to slipping while developing a large horsepower when running at relatively high speeds.

As far as the longitudinal forces are concerned, the three-cylinder is self-balanced, and it is only necessary to consider the effect of the couples which tend to rotate the engine in a horizontal plane and possibly it may be found that no balancing for the reciprocating weights is necessary.

The dynamometer car records show that the drawbar pull is much steadier than in a corresponding two-cylinder engine.

Owing to the smaller piston loads and the fact that the inside piston partly opposes the thrust of the outside, the wear on driving boxes is reduced, there is less shock in the reversals of steam loads and, moreover, there is a larger bearing area available for carrying loads. As a consequence, wear is reduced generally.

It is found possible in British practice to accelerate trains from rest or to work slowly up a heavy grade with full throttle and maximum cut-off without undue disturbance to the fire due to the six light exhaust beats per revolution of the wheels. It is also found practicable, owing to the excellent balancing, to run heavy passenger trains at 70 miles per hour with 68-in. driving wheels. Hence three-cylinder locomotives can be said to possess a large degree of flexibility in working as they are not only eminently suited for pulling heavy loads, but also for fast running.

One of the problems in the design of three-cylinder engines is the question of the inside valve gear. After some study of this subject in 1908 the writer devised a means of operating the inside valve from the outside gears by the use of rockers. About the same time H. S. Vincent of New York also devised a somewhat similar arrangement, and this was described by J. Snowden Bell in the Proceedings of the American Master Mechanics' Association, Vol. XLVI, 1913. Since then the same principle has been discovered in Germany and put into practical use. On the other hand, the North Eastern Railway (England) prefers three complete sets of link motion, a total of six eccentrics on the driving axle. Locomotives built by Borsig in Berlin have an independent Walschaert gear inside the frame, driven from an additional return crank on the outside through a rocker. An independent gear gives a more nearly correct result, but it is often difficult to apply. The resulting motion from the combination of the two outside gears is not an exact reproduction of the primary gears, but it is sufficiently near for practical purposes. If the primaries were pure harmonies, the inside valve would also have a harmonic motion. As it is, the primary valve gear gives a periodic motion compounded principally of a harmonic and a small octave at a phase of 90 deg. and twice the frequency. When the two outer gears are combined, the resulting motion is influenced by these small octaves, but not sufficiently to matter, even in full gear of 75 per cent. As a maximum of 66 per cent cut-off is all that is necessary in three-cylinder engines, the small irregularities of motion are diminished and at 25 per cent there is little or no difference to be detected.

The design of the cylinders has advanced considerably and steam and exhaust passages are simple and direct while joints under steam pressure are avoided. Some recent designs are suitable for either plate or bar framing.

The crank axle is reduced to its simplest form. In some cases it is forged and the webs slotted out, as is usual in British practice. In another form the axle is bent to shape. A third way is to build up the axle. This enables special steels to be used for the construction, and any part that may break in service can be replaced without scrapping the whole axle. Again, the bearing surface of the crank pin is more effective due to the absence of round corners on the journal; and the crank webs can be prolonged so as to form balance weights. In this way the whole of the revolving parts are balanced in their own plane, thereby relieving the axle of bending stresses due to centrifugal force. The balance weights in the wheels are correspondingly reduced.

The first railway to adopt extensively the use of three high-pressure cylinders in conjunction with a superheater was the North Eastern of England. This practice was followed some two or three years later by the Prussian State Railways

in Germany. Since then a large number of these engines have been built in Europe.

It remains to be proved whether the three-cylinder locomotive is adapted to American conditions. The 15 per cent greater cylinder capacity offers an alternative to the booster, or in conjunction with that device an even greater hauling capacity.

H. Holcroft.

Economy of Balanced Compound Locomotives

Dallas, Tex.

To the Editor:

When efforts are made to prevent avoidable waste in locomotive operation, the possibilities of a properly designed superheated balanced compound, over an equally well-designed superheated simple engine for certain classes of service, should receive consideration. Heavy high-speed passenger and fast freight service offer the best field for this type. By a properly designed compound I mean one having separate valves and an independent cut-off for the low-pressure cylinders. This is essential if the best results are to be obtained. It is generally contended that the compound locomotive is too complicated and that the upkeep is too high. While it must be admitted that there are more parts to the compound, the fact that the driving stresses are distributed through four sets of gears instead of two results in considerably less wear and tear on the machine as a whole and a greater mileage between shoppings.

In the following table, which was published by a large western road in the days when compounds were used considerably and which shows results obtained over a period of 15 months, it will be seen that there was practically no difference in the cost of repairs between the compound and the simple locomotives:

Locomotive	Locomotive miles	Gross ton-miles	Repairs per locomotive-mile	Repairs per 1,000 gross ton miles
Compound A	56,886	42,146,900	$.0161	$.0217
Compound B	60,234	49,070,628	$.0154	$.0182
Compound C	54,497	42,404,236	$.0154	$.0198
Compound D	51,248	40,544,366	$.0121	$.0153
Simple 507	52,915	31,400,344	$.0166	$.0280
Simple 520	63,234	38,163,393	$.0120	$.0198
Simple 566	52,738	34,612,835	$.0184	$.0284

Another objection raised against the compound is that it cannot be built to develop the same power as the modern simple engine. This is true as regards the largest modern freight locomotives, but for passenger service it is possible to build a Pacific type locomotive with 21 in. by 33 in. by 28 in. cylinders, 200 lb. boiler pressure and 72-in. wheels which would develop 44,000 lb. tractive force. This is equal to the average simple Pacific type, and as such locomotives are often used for fast freight service, this objection will not hold good as far as these two classes of service are concerned. A freight engine having 22 in. by 34 in. by 32 in. cylinders, 225 lb. boiler pressure and 63-in. drivers would develop 69,000 lb. tractive force, which is equal to the best Mikado. Both the above sets of figures can be increased at starting by admitting live steam to the low pressure cylinders if necessary.

At high speeds the compound will deliver more power than a simple engine owing to the better cylinder action resulting from the later cut-off reducing wire-drawing of the steam to a minimum, and also the increased range of expansion, while at low speeds on grades it is less liable to slip and stall owing to the more even torque on the crankpins. They are smoother running machines due to the perfect mechanical balance and to the less varied mean effective pressure in the cylinders. This is an advantage both to the machine itself and the track, especially where light steel is used and the roadbed is not the best.

In the following table is given the results of tests carried out on the Paris, Lyons & Mediterranean Railway in France between a superheated simple and a superheated compound locomotive. The only difference in these two engines is that due to the double expansion of steam in the compound and two extra sets of valve gears for the low pressure cylinders.

The cylinder dimensions of the compound are 17.1 in. by 25.7 in. by 25.7 in.

Weight of trains	Mean consumption per indicated horsepower hour—simple Water	Coal	Mean consumption per indicated horsepower hour—compound Water	Coal
278 tons	19.07 lb.	3.1 lb.	14.21 lb.	2.35 lb.
	19.58 lb.	3.49 lb.	14.56 lb.	2.37 lb.
487 tons	21.49 lb.	3.23 lb.	14.12 lb.	2.35 lb.
	20.59 lb.	3.3 lb.	14.8 lb.	2.13 lb.
646 tons			13.53 lb.	2.05 lb.
			14.2 lb.	2.06 lb.

The above tests were made on the 95-mile division between Laroche and Dijon, which is nearly all up hill, at speeds ranging between 55 and 65 miles an hour. Two tests were run with each load to avoid the possibility of error and it will be seen that the results agree very closely. The maximum horsepower indicated by the compound was 2,425 and for the simple, 2,051. As a result of these tests, which were borne out by the every-day performance of the compounds, 91 simple engines were converted to compound.

The decreased water consumption of the compound means longer runs without stopping for water, resulting in less wear and tear on equipment due to starting and stopping heavy trains, and also a saving in the fuel necessary to work heavy trains up to speed. The time between washout periods can also be lengthened.

In designing a compound engine it is necessary to have separate valves and valve gear for each set of cylinders so that the cut-off to the low-pressure cylinders can be later than to the high pressure. This is especially advisable at high speeds when it is necessary to have a large port area to handle the large volume of low pressure steam quickly.

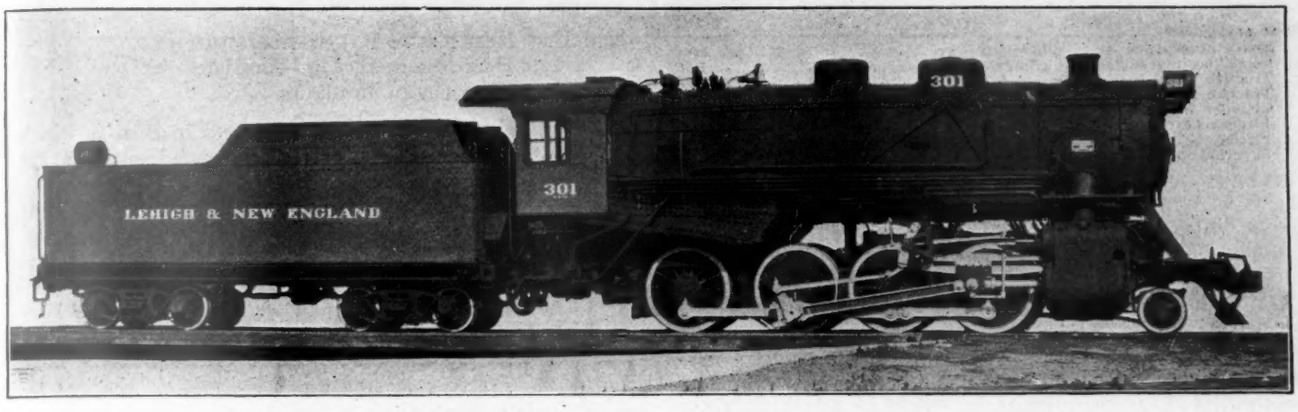
The Walschaert valve gear can easily be arranged for independent cut-off to both cylinders, by setting both links side by side and working them by one eccentric rod. The crosshead arms are set one on each side of the low-pressure crosshead and connected to both combination levers, and an indirect rocker arm is used to transmit the motion to the high-pressure valves between the frames. This system has practically all the gearing outside the frames where it is readily accessible for repairs and oiling.

The high-pressure exhaust should be led to a common chamber from which it passes to the low-pressure steam chests. This is an advantage in certain classes of breakdowns, as it is possible to use three cylinders to bring the train in. This chamber should be connected to a pressure gage in the cab which will act as a guide to the engineer in adjusting the low-pressure cut-off.

Since the modern locomotive is becoming a regular power plant on wheels, with its superheater, feedwater heater, mechanical stoker and booster, why not adopt double-expansion where operating conditions are suitable when it will give 25 per cent and 35 per cent economy in fuel and water respectively? Where a number of such engines are used on a division, their operation should show a good profit on the added investment involved in their construction and upkeep.

P. D. Anderson.

A Motor or other part of electrical equipment is desired to do its work at a certain voltage and should not be expected to do its work properly unless this voltage is maintained within reasonable limits. Low voltage means a heavy current in the winding, which overheats the wiring, tending to destroy the insulation. Too high a voltage is also dangerous, as the spacing between parts has not been arranged for higher pressure and arcs are often caused which break down the insulation with resultant serious damage.—Bureau of Mines.



Consolidation Locomotive Weighing 301,500 *lb. and Having a Tractive Force of* 68,200 *lb.*

Powerful Consolidation Locomotive for L. & N. E.

Unusually Heavy Weight and High Tractive Force with Well-Proportioned Boiler Are Special Features of This Design

COMPARATIVELY few locomotives of the 2-8-0 type have been built during recent years for use on American railways. While this was a popular type of freight locomotive for a long period, it has largely been superseded by the Mikado type because of the increased depth of firebox and length of boiler barrel, with correspondingly increased boiler capacity, which can be obtained when a trailing truck is added. However, the Consolidation locomotive is still a highly desirable type where high tractive force combined with low total weight is the important factor as it is where heavy trains, moved at slow speeds, comprise the bulk of the traffic. By careful designing, a boiler of sufficient capacity can be obtained for such service if road clearance does not impose too many restrictions.

Conditions on the Lehigh & New England are especially suited to the operation of Consolidation type locomotives. Most of the traffic is drag freight. Since the road is close to the coal mining section fuel is relatively cheap. The vertical clearance of 15 ft. 8½ in. gives room above the driving wheels for a boiler of large diameter with a deep throat sheet. The bulk of the power is of the Consolidation type and in adding to the number of its locomotives it was decided to adhere to the same type, but to increase the capacity over that of the older locomotives, which had 208,000 lb. on the drivers.

The four Consolidation type locomotives built by the American Locomotive Company which this road has placed in service recently are excellent examples of well-designed engines to meet special conditions. Weighing 301,500 lb. with 279,000 lb. on the drivers, they are the heaviest Consolidation locomotives ever constructed. The previous record for size with this type was made by the locomotives built by the Baldwin Locomotive Works for the Western Maryland and described in the *Railway Mechanical Engineer*, July, 1921. In several particulars the weights and dimensions are the same for the two designs. Both have 27-in. by 32-in. cylinders, 61-in. drivers, 17-ft. 6-in. driving wheel base, and a rated tractive force of 68,200 lb. The Lehigh & New England locomotives have boilers with a larger grate area and more heating surface, which is reflected in the increase of 6,600 lb. in weight.

The height from the rail to the center of the boiler is 10 ft. 4 in. and to the top of the stack is 15 ft. 8½ in. The firebox is 126⅛ in. long by 96¼ in. wide, while the height from the bottom of the foundation ring to the crown sheet is 83½ in. at the front and 57¼ in. at the back, which gives a fair firebox volume and sufficient space for the application of a brick arch. There are 301 2-in. tubes and 50 5⅜-in. flues. The total evaporative heating surface is 3,666 sq. ft., of which 271 sq. ft. is in the firebox. The superheater has 901

Dimensions, Weights and Proportions

Type	2-8-0
Service	Drag freight
Cylinders, diameter and stroke	27 in. by 32 in.
Valves, kind and size	Piston — 14 in.
Maximum travel	7 in.
Outside lap	1 3/16 in.
Exhaust clearance	0 in.
Lead in full gear	⅛ in.
Weights in working order:	
On drivers	279,000 lb.
On front truck	22,500 lb.
Total engine	301,500 lb.
Tender	184,100 lb.
Wheel bases:	
Driving	17 ft. 6 in.
Total engine	26 ft. 11 in.
Total engine and tender	65 ft. 2 in.
Driving wheels, diameter outside tires	61 in.
Boiler:	
Type	Straight top
Steam pressure	210 lb.
Fuel, kind	Soft coal
Diameter, first ring, inside	88 in.
Firebox, length and width	126⅛ in. by 96¼ in.
Height to crown sheet, back	57¼ in.
Height to crown sheet, front	83½ in.
Tubes, number and diameter	301 — 2 in.
Flues, number and diameter	50 — 5⅜ in.
Tubes and flues, length	15 ft.
Grate area	84.3 sq. ft.
Heating surfaces:	
Firebox, including arch tubes	271 sq. ft.
Tubes	2,349 sq. ft.
Flues	1,046 sq. ft.
Total evaporative	3,666 sq. ft.
Superheating	901 sq. ft.
Comb. evaporative and superheating	4,567 sq. ft.
Tender:	
Water capacity	10,000 gal.
Coal capacity	16 tons
General data, estimated:	
Rated tractive force, 85 per cent	68,200 lb.
Cylinder horsepower	2,755 hp.
Boiler horsepower	2,420 hp.
Speed at 1,000 ft. piston speed	34 m.p.h.
Steam required per hour	5,730 lb.
Boiler, evaporative capacity per hour	5,030 lb.
Coal required per hour, total	8,950 lb.
Coal, rate per sq. ft. grate per hour	106 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine	92.6 per cent
Weight on drivers ÷ tractive force	4.08 lb.
Total weight engine ÷ tractive force	4.42
Total weight engine ÷ cylinder horsepower	109.4 lb.
Total weight engine ÷ boiler horsepower	124.5 lb.

Boiler proportions:

Boiler horsepower ÷ cylinder horsepower	87.9 per cent
Comb. heating surface ÷ cylinder horsepower	1.66
Tractive force ÷ comb. heating surface	14.93
Tractive force × dia. drivers ÷ comb. heating surface	911
Cylinder horsepower ÷ grate area	32.7
Firebox heating surface ÷ grate area	3.21
Firebox heating surface ÷ evap. heating surface	7.4
Superheating surface ÷ evap. heating surface	24.6

sq. ft. heating surface. The rated boiler capacity is 2,420 hp., or 88 per cent of the cylinder power, which is 2,755 hp., a proportion which has been found to be ample for the conditions under which these locomotives are operated.

Of the total weight of the locomotive 92.6 per cent is on the drivers and available for adhesion, whereas with the typical Mikado locomotive the weight on the drivers is nearer 75 per cent. The factor of adhesion is 4.08. The possibilities of excellent use of the weight by a Consolidation type is shown by the fact that the total weight is only 109.4 lb. per cylinder horsepower and 4.42 lb. per pound of rated tractive force, figures that can scarcely be equalled by a locomotive of the 2-8-2 type.

Two of these locomotives are hauling coal trains of 3,500 gross tons from Lansford to Pen Argyl, a distance of 54 miles, part of which is up a 0.5 per cent grade, at a speed of approximately 20 m. p. h. Two others are running out of Pen Argyl and handling 690 gross tons up a 2.75 per cent grade without difficulty. While no test runs have been made, it has been observed that these locomotives are free steamers, of ample boiler capacity and consume a conservative amount of fuel.

The leading dimensions, weight distributions and proportions of these locomotives are given in the table.

The Insulation of Boilers and Heated Surfaces

By Wm. N. Allman

IN the insulation of locomotive boilers the one very important feature is to conserve the heat and thereby reduce the loss by radiation to a minimum. The value of such insulation is therefore a matter of importance.

The unit of heat is a B. t. u. There is no insulation that is 100 per cent efficient, but the real object of insulation is to prevent to the highest degree the flow of heat to the outside surrounding air from the boiler surface. The conductivity of the material determines the rate of flow with a given difference in temperature. A smaller number of heat units (B. t. u.) will flow through an insulating material with a low than one with a high conductivity.

The efficiency of an insulating material is expressed by a percentage which represents the per cent saving which would be realized by insulating the boiler with such a material over what would be lost if the surface were left bare. The efficiency is then obtained by subtracting the heat loss of the insulated surface from the heat loss of the uninsulated or bare surface, and dividing the result by the heat loss from the bare surface. Expressed as a formula, this would be as follows:

$$E = \frac{U - I}{U}$$

where U = Heat loss in B. t. u.—bare surface
I = Heat loss in B. t. u.—insulated surface
E = Efficiency of insulation

In Table I the figures represent the loss in B. t. u. which would be expected with bare or uninsulated surfaces for temperatures ranging from 0 to 500 deg. F.

Table II represents the efficiencies of an 85 per cent magnesia boiler lagging in thicknesses from 1 in. to 3 in. It is highly important that material thick enough be applied in order to secure the best results. Another important feature is to cover every square foot of exposed surface. By this is meant the firebox area as well as the shell of the boiler. While a number of railroads have not adopted the practice of covering the exposed area of the outside firebox sheets, it is a mistake to allow them to go uninsulated when it is considered that there is an enormous heat loss which may be saved.

By referring to the figures contained in Table III, it can be readily seen what this loss amounts to in the course of a year.

TABLE III

Steam pressure gage	Steam temperature	Difference between temperature of steam and surrounding air F.	Loss per sq. ft. per hr. (B.t.u.)	Waste of coal lb. per sq. ft. per year based on 300 days of 10 hrs. each	Number of sq. ft. of surface that wastes a ton of coal in one year
0	212	142	334.0	77.0	26.00
10	240	170	425.0	98.0	20.40
25	267	197	522.5	120.6	16.58
50	298	228	644.0	149.0	13.42
75	320	250	737.5	170.2	11.75
100	338	268	820.0	189.2	10.57
150	366	296	960.0	221.6	9.02
200	388	318	1,079.0	249.0	8.03
250	406	336	1,184.0	273.2	7.32

(Temperature of surrounding air 70 deg. F.)

Note:—Above figures based on coal having an average heat value of 13,000 B.t.u.

To determine the amount of heat saved by the application of 85 per cent magnesia lagging, we may consider a locomotive boiler carrying a boiler pressure of 200 lb. per sq. in., the corresponding temperature being 388 deg. F. Assuming an outside temperature of 70 deg. F., we obtain a difference in temperature of 318 deg. F. Referring to Table I, the loss under these conditions would be 1,079.0 B. t. u. per hour per sq. ft., and for coal having an average thermal content of 13,000 B. t. u. this would equal a waste of 249.0 lb. of fuel as shown in fourth column of Table III for each square foot of surface per year under the conditions as shown; namely, 300 days of 10 hrs. each.

By the application of 85 per cent magnesia sectional lagging with its high insulating value, the major portion of this loss may be saved and converted into useful work, and by referring to Table II the following efficiencies are obtained by interpolation:

	Efficiency	Lb. coal saved per sq. ft. per year
1½ in. thick lagging	91.43 per cent	227.6
2 in. thick lagging	93.33 per cent	232.4
2½ in. thick lagging	94.57 per cent	235.5
3 in. thick lagging	95.40 per cent	237.5

This shows that even the thinnest insulation will show a large saving by preventing the escape of heat from the surfaces.

TABLE I.

	50 deg.	100 deg.	150 deg.	200 deg.	250 deg.	300 deg.	350 deg.	400 deg.	450 deg.	500 deg.
B.t.u. per square foot per hour....	97.5	215.2	360.0	533.0	737.8	978.0	1,269.4	1,614.0	2,050.6	2,590.0

TABLE II

Thickness of insulation	Temperature difference between hot surface and surrounding air: 50 deg.	100 deg.	150 deg.	200 deg.	250 deg.	300 deg.	350 deg.	400 deg.	450 deg.	500 deg.
	Per Cent Efficiencies									
1 in.	80.80	82.36	83.90	85.25	86.48	87.60	88.70	89.64	90.56	91.48
1½ in.	86.25	87.40	88.53	89.49	90.37	91.16	91.94	92.65	93.32	93.97
2 in.	89.32	90.16	91.08	91.85	92.53	93.12	93.71	94.27	94.80	95.31
2½ in.	91.19	91.95	92.69	93.32	93.87	94.38	94.87	95.31	95.73	96.14
3 in.	92.55	93.22	93.83	94.37	94.82	95.25	95.67	96.06	96.40	96.75

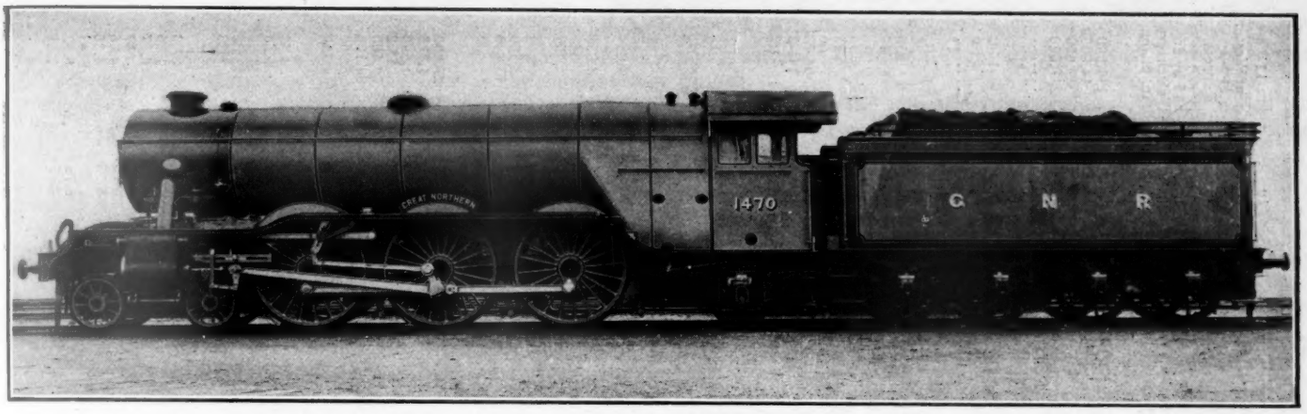


Fig. 8—Great Northern, Three-cylinder, 4-6-2 Type Express Passenger Locomotive

Recent Tendencies In British Locomotive Practice

Part II

Pacific Type Locomotives for Great Northern and North Eastern Are of the Three-Cylinder Type; Great Western Uses Four Cylinders

By E. C. Poultney

FOR many years 4-6-0 type express locomotives have been used by most railways where the demands of the traffic required greater capacity than could be obtained by four coupled engines. The 4-6-0 and 4-4-2 engines described by the writer in the *Railway Mechanical Engineer* for November, 1916, are still representative of the leading examples in service; in fact, with the exception of some two-cylinder 4-6-0 engines and the new three-cylinder engine of the same wheel arrangement built for the Caledonian and certain large 4-6-0 locomotives having four cylinders and others having two, put into traffic on the Great Central and London & South Western, no passenger engines of what may be called a new design have been built for some years.

The Atlantic type has been used to a limited extent by some railways, thus the Great Central and Great Western both gave the type a trial by building engines of the 4-6-0 and 4-4-2 type, with the same boiler design on each, but subsequent locomotives for maximum power on each of these lines have been of the 4-6-0 type; on the other hand, the North Eastern, the first line to build 4-6-0 express engines, gave them up in favor of the Atlantic type about 1903, and the Great Northern commenced to build Atlantics in 1898 and have continued to use this type up to the appearance of the Pacifics, the first of which has just been constructed.

Development of the Pacific Type

Recently some interesting developments have occurred and these take the form of two new designs of Pacific type locomotives, the first of this type to be placed on a British line since "The Great Bear" was built at Swindon in 1908 for the Great Western. The new engines are for the Great Northern and North Eastern. Both these railways have for many years used 4-4-2 engines for express passenger traffic. The North Eastern at one time used 4-6-0 engines, but gave them up for Atlantics about 15 years ago, and the Great Northern has never used the 4-6-0 design.

The Great Northern 4-6-2 type locomotive, Fig. 8 and Fig. 9, was built at the Doncaster shops to the designs of H. N. Gresley, who kindly provided the photographs.

The Atlantic engines, the last of which was built 11 years ago, although of relatively low tractive force, have in consequence of their considerable boiler capacity done excellent work on the Great Northern but the increasing weight of the trains has necessitated the introduction of locomotives of a greater tractive force.

The boiler of the Great Northern engine is the largest which has so far been used in British practice, and in its dimensions practically reaches the permissible limits of the comparatively small loading gage of British railways. The barrel portion is composed of two sections, a taper length coming next the fire-box, and a parallel section forward to the smoke box. A single plate is used for each, that is, the barrel is formed from two plates only. The diameter of the tapered length where it joins the fire-box is 77 in., and forward where it joins the front portion it is 69 in. and the length is 19 ft.

A wide fire-box of the round top design is used, and the back head slopes forward from the foundation ring as in American practice. The fire-box casing is 78 in. in diameter at the front, and tapers to 73 in. at the back; the casing is 9 ft. 5½ in. long, and at the bottom the length is 6 ft. 8 in., with a width of 7 ft. 9 in. The internal fire-box is of a design not before used in English practice, and as will be seen from Fig. 10, it resembles the design now common in American locomotives. By extending the box forward into the barrel section capacious proportions have been obtained and the tubes have been kept to a moderate length, the distance between the tube sheets being 19 ft.

There are 168 tubes 2¼ in. and 32 flues 5¼ in. in diameter, and the ratio between the inside diameter of the tubes and the length between the tube sheets is 1 to 114. The tubes comprising the units of the Robinson superheater are 1½ in. outside diameter. The fire-box is of copper, and the tubes are solid drawn steel. The center line of the boiler is unusually high, being 9 ft. 4½ in. from the rails. The height to the top of the stack is 13 ft. 4 in.

Turning now to the engines, these are of Mr. Gresley's standard three-cylinder type, that is to say, they follow in

DIMENSIONS, WEIGHTS AND PROPORTIONS OF RECENT BRITISH LOCOMOTIVES

	1	2	3	4	5	6	7	8	9	10	11
Railroad	Great Central	North Eastern	Caledonian	North British	Great Western	Great Eastern	Great Eastern	Great Northern	Great Northern	North Eastern	Great Western
Type of locomotive	4-6-0	4-6-0	4-6-0	4-4-2	2-8-0	4-6-0	0-6-0	2-6-0	4-6-2	4-6-2	4-6-2
Service	Fast freight	Fast freight	Express	Express	Fast freight	Express	Freight	Fast freight	Express	Express	Express
Cylinders, number of	4	3	3	2	2	2	2	3	3	3	4
Cylinders, diameter and stroke, in.	16 by 26	18½ by 26	18½ by 26	21 by 28	19 by 30	20 by 28	20 by 28	18½ by 26	20 by 26	19 by 26	15 by 26
Valve gear	Stephenson	Stephenson	Walschaert	Stephenson	Stephenson	Stephenson	Stephenson	Walschaert	Walschaert	Stephenson	Walschaert
Valves, kind and size	Piston	8¾ in. piston	8 in. piston	Piston	Piston	10 in. piston	10 in. piston	8 in. piston	8 in. piston	8¾ in. piston	8 in. piston
Weights in working order:											
On drivers, lb.	131,000	131,500	134,500	89,600	164,400	97,600	122,700	134,400	134,400	134,400	134,000
On front truck, lb.	47,000	46,600	47,000	39,500	19,300	46,000	.....	26,400	38,200	42,600	44,000
On trailing truck, lb.	.....	.....	.....	42,700	.....	.....	.....	.....	34,500	40,300	39,000
Total engine, lb.	178,000	174,100	181,500	171,800	183,700	143,600	122,700	160,800	207,100	217,300	217,000
Tender, lb.	108,000	103,000	94,500	102,700	89,600	83,400	85,300	96,500	126,100	103,100	.....
Wheel bases:											
Driving, ft. and in.	14-5	13-6	15-0	7-3	20-0	14-0	18-10	16-3	14-6	15-0	14-0
Total engine, ft. and in.	28-3	27-8	28-8	27-9½	29-3	28-6	18-10	25-2	35-9	37-2	34-6
Total engine and tender, ft. and in.	52-9½	52-5⅜	54-0½	53-1½	56-9¾	48-3	.....	48-0¼	60-10⅝	61-11¾	.....
Wheels, diameter outside tires:											
Driving, in.	68	68	73	81	68	78	59	68	80	80	80½
Front truck, in.	42	37¼	42	42	38	39	.....	38	38	37¼	38
Trailing truck, in.	.....	.....	.....	51	.....	.....	.....	.....	44	45¼	44
Boiler:											
Steam pressure, lb. per sq. in.	180	180	180	180	225	180	180	180	180	200	225
Diameter, first ring outside, in.	63½	66	67½	66	66	60	60	72	69	72	66
Firebox, length and width, in.	93-40⅛	108-47	111 long	.....	110⅜-62⅜ to 385⅛	102-49½	102-49½	.....	.....	.....	96-78
Tubes, number and diameter, in.	116-2¼	102-2	203-2	141-2	218-2	187-1¾	187-1¾	217-1¾	168-2¼	118-2¼	141-2½
Flues, number and diameter, in.	28-5¼	24-5¼	24-5	24-5	18-5⅛	21-5¼	21-5¼	32-5¼	32-5¾	24-5¼	21-4¾
Tubes and flues, length, ft. and in.	17-7⅜	16-2⅝	16-0	15-4¾	15-2½	12-10	12-10	11-11⅞	19-0	21-0	22-7
Tubes spacing	.....	1¼	1⅜	.....	¾	1⅜	1⅜	1½	¾	.....	1⅜
Flue spacing	.....	1⅛	1	.....	1⅛	1⅛	1⅛	1	1	.....	1⅛
Air inlet through grates, sq. ft.	8.75	6.5	6.8	18.7	13.05	12.85	12.85	8.1	11.1	.....	18
Air inlet through ash pans, sq. ft.	4.9	5.2	3.4	3.15	.....	5.8	4.4	3.55	5.85	.....	.....
Grate area, sq. ft.	26	27	28.5	28.5	30.3	26.5	26.5	28	41.25	41	41.8
Heating surfaces:											
Firebox, sq. ft.	163	166	170	185	170	144	144	182	215	211	182
Tubes, sq. ft.	1,203	866	1,700	1,136	1,702	1,099	1,099	1,232	1,889	1,518	2,084
Flues, sq. ft.	678	532	500	483	360	366	366	487	836	693	589
Total evaporative, sq. ft.	2,044	1,564	2,370	1,804	2,232	1,609	1,609	1,901	2,940	2,422	2,855
Superheating, sq. ft.	343	530	270	385	324	286	286	407	525	696	545
Comb. evap. and superheating, sq. ft.	2,387	2,094	2,640	2,189	2,556	1,895	1,895	2,308	3,455	3,118	3,400
Tender:											
Water capacity, Imp. gal.	4,000	4,125	4,500	4,240	3,500	3,700	3,500	3,500	5,000	4,125	3,500
Fuel capacity, lb.	13,440	11,770	12,500	15,700	11,000	8,960	11,200	14,580	11,200	12,310	13,440
Wheels, number and size, in.	6-52	6-45¼	6-48	6-	6-	6-49	6-	6-50	8-50	6-45¼	8-
General data, estimated:											
Rated tractive force, 85 per cent	29,950	30,030	28,000	23,400	30,600	22,000	29,040	30,030	29,835	29,920	27,800
Cylinder horsepower (Cole)	1,660	1,665	1,665	1,430	1,460	1,295	1,295	1,665	1,945	1,950	1,825
Boiler horsepower (Cole)	.....	1,195	1,573	.....	1,460	1,095	1,095	1,405	1,842	.....	1,640
Speed at 1,000 ft. piston speed	46.7	46.7	50.1	51.5	40.5	49.7	37.7	46.7	54.8	54.8	55.2
Steam required per hour	34,590	34,610	34,610	29,750	30,400	27,000	27,000	34,610	40,400	40,600	39,100
Boiler, evaporative capacity per hr.	.....	24,920	32,705	.....	30,490	22,780	22,780	29,240	38,275	.....	34,100
Coal required per hour, total	5,390	5,400	5,400	4,640	4,760	4,220	4,220	5,420	6,440	6,350	5,960
Coal, rate per sq. ft. grate per hour	207	200	190	163	157	159	159	193	153	155	143
Weight proportions:											
Weight on drivers ÷ tractive force	4.45	4.34	4.80	3.83	5.37	4.43	4.23	4.43	4.53	4.49	4.83
Weight on drivers ÷ total weight engine	73.6	75.4	74.1	52.5	89.5	67.9	100	83.6	64.9	62.0	62.5
Total weight engine ÷ cylinder horsepower	107.1	104.6	109.0	119.3	125.7	110.7	94.7	96.6	106.0	111.2	117.9
Total weight engine ÷ boiler horsepower	.....	145.6	115.3	120.1	125.7	131.1	112.1	114.5	112.4	.....	126.2
Total weight engine ÷ comb. heating surface	74.6	82.7	68.6	78.5	71.9	75.7	64.7	69.5	60.0	69.7	75.3
Boiler proportions:											
Boiler horsepower ÷ cylinder horsepower	.....	72.0	94.6	.....	100	84.6	84.6	84.5	94.8	.....	87.3
Comb. heating surface ÷ cylinder horsepower	1.44	1.28	1.58	1.53	1.68	1.46	1.46	1.38	1.77	1.58	1.86
Tractive force ÷ comb. heating surface	12.5	14.2	10.6	10.7	12.4	11.6	15.3	13.0	8.65	9.66	8.17
Tractive force × diam. drivers ÷ comb. heat. surf.	852	980	775	870	850	906	905	885	690	767	667
Cylinder horsepower ÷ grate area	63.8	61.6	58.3	50.1	48.6	48.9	48.9	59.4	47.2	47.6	43.6
Firebox heating surface ÷ grate area	6.27	6.38	5.96	6.48	5.58	5.43	5.43	6.50	5.22	5.13	4.36
Grate air inlet ÷ grate area	34	24	24	65	43	48	48	29	27	.....	43
Firebox heating surface ÷ evap. heating surface	7.97	10.60	7.17	10.25	7.95	8.95	8.95	9.53	7.31	8.71	6.37
Superheat. surface ÷ evap. heating surface	16.7	21.0	11.4	21.3	15.15	17.7	17.7	21.35	17.9	28.7	19.1

detail design those used for the 2-6-0 and 2-8-0 locomotives, but the cylinders are each 20 in. in diameter as against 18½ in. for the other engines, while the stroke is the same, viz., 26 in.

The piston valves have a diameter of 8 in. and are operated by two sets of Walschaert gear applied to the outside motion, and the valve for the center cylinder is operated by the combined movement of the two sets of valve motion as in the case of the 2-6-0 engines already described.

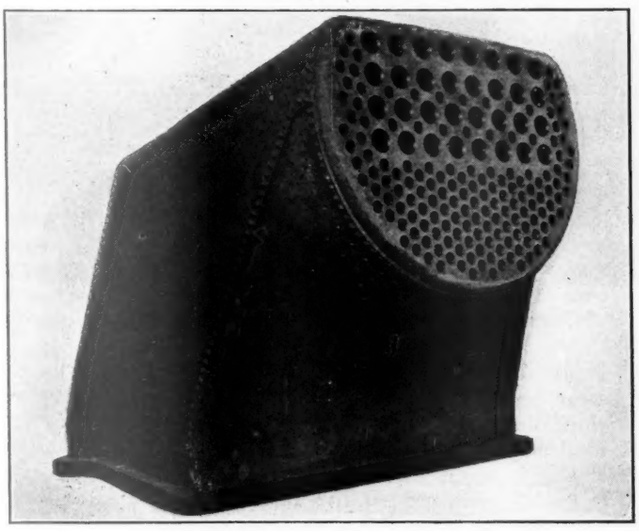


Fig. 10—Firebox of Great Northern Pacific Type Locomotive

The inside cylinder is placed over the trailing wheels of the leading truck, and arranged with its center line inclined at 1 in 8 to clear the leading axle so that the drive is, like in the 2-6-0 engines, all through the center coupled wheels. The crank pins are at 120 degs.

The main, side and piston rods, the latter hollow, are made of nickel-chrome steel, as are also the piston heads and the crossheads of light design which are carried in three-bar guides.

The pins for the return cranks of the valve gear are fitted with ball bearings, and the long transverse lever forming part of the gear for the inside cylinder valve is pivoted on a roller bearing.

Laminated springs of 42 in. centers carry the weight on the leading and trailing coupled axles, and the driving boxes are fitted with helical springs.

The trailing truck axle is fitted with special axle boxes allowing a radial movement of 2½ in. each way; this, together with the flexibility furnished by the leading truck, enables the engines to negotiate 22 deg. curves.

The tender is of unusual design, as it is carried on four axles, and these are not in the form of trucks. It has a capacity of 5,000 gal. of water and 8 tons of coal, and is fitted with a water scoop.

The fittings include two injectors (the one on the left hand side being of the exhaust steam pattern), screw reversing gear, steam sanders and a pyrometer. Wakefield's mechanical lubricators are fitted, one for the cylinders and valves, and another for lubricating the journals of the coupled axles. The automatic vacuum brake is used.

The total weight of the engine only in working trim is 206,000 lb., and of this 134,400 lb., or 65 per cent, is carried on the coupled axles. The engine weight per square foot of evaporative heating surface is 70.6 lb., and per square foot of total heating surface, boiler and superheater, 60 lb.

The North Eastern Pacific engines, Fig. 11, have three cylinders and in conformity with Sir V. Raven's usual practice they are all made in one casting, and the drive is taken by the leading coupled axle. To obtain sufficient length for the three connecting rods, the distance between the cylinder and driving axle centers is 10 ft. 11 in., and this, combined with the liberal distance between the centers of the coupled axles, which is 7 ft. 6 in. as against 7 ft. 3 in. for the Great Northern Pacifics, makes the total engine wheel base very long, namely, 37 ft. 2 in., which length is reflected in the

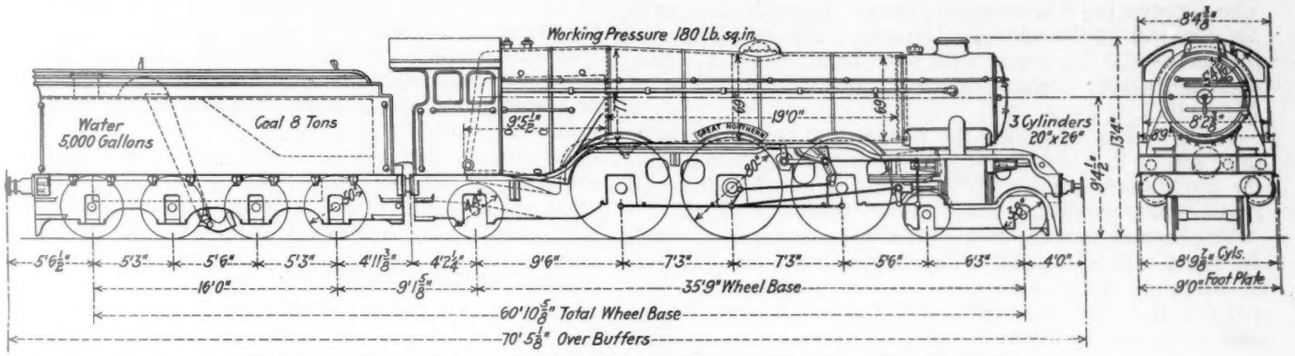


Fig. 9—Diagram of Three-cylinder Pacific Type Locomotive, Great Northern Railway

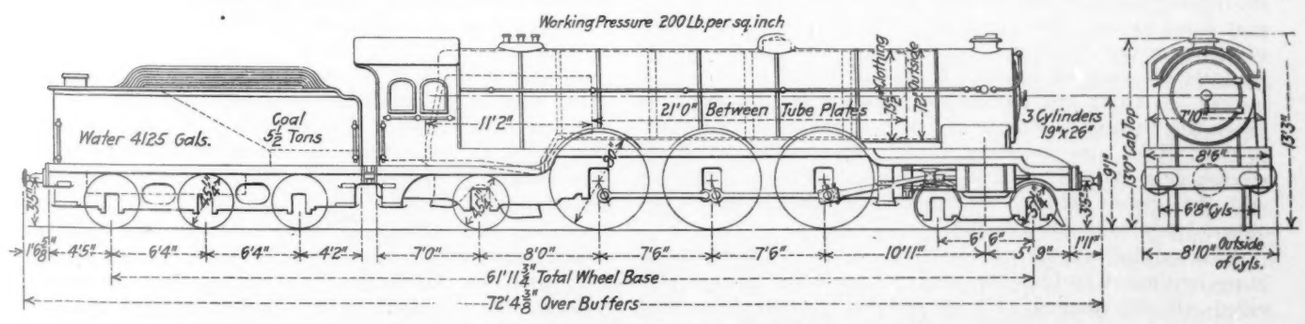


Fig. 11—Diagram of Three-Cylinder Pacific Type Locomotive, North Eastern Railway

length of the boiler, which has tubes no less than 21 ft. long.

The fire-box is of considerable size, and is extended forward into the barrel portion of the boiler, the length from outside the back head at the foundation ring to the fire-box tube sheet being 11 ft. 2 in. The barrel is in four sections, butt jointed, and its center line is 9 ft. 1 in. above the rails. The diameter is 72 in. over the plates. There are 118 tubes 2¼ in., and 24 flues 5¼ in. diameter. The working steam pressure is 200 lb., which, with three 19 in. by 26 in. cylinders and 80 in. drivers, gives a rated tractive force of 29,920 lb.

Piston valves distribute the steam, and are operated by three sets of link motion, all six eccentrics being mounted on the single throw crank axle. The trailing axle is fitted with radial boxes, permitting a 3½ in. movement.

The engines have six-wheeled, self-trimming tenders which are fitted with water pick-up apparatus and carry 5½ tons of coal and 4,125 gal. of water, and weigh when full 103,100 lb. The Westinghouse brake acts on the engine and tender, and an ejector is fitted for working the automatic vacuum brake on the train when required.

The Great Western locomotive "The Great Bear," Fig. 12, was placed in traffic in 1908, and when built was much the largest locomotive ever used on a British railway. The engine also was the first Pacific type tender engine built, and remained the sole British representative of this type till the Great Northern engine left the Doncaster shops in May of the present year. In designing "The Great Bear" G. J. Churchward adhered closely to the practice followed in the four-cylinder engines of the 4-6-0 type, the chief difference being in the boiler, which is much larger and has a wide fire-box equipped with arch tubes. The four cylinders are 15 in. by 26 in., and those between the frames are placed well forward to allow sufficient length for the main rods which drive the leading wheels through a crank axle. The outside cylinders drive the middle axle, and each has an 8-in. piston valve of the inside admission type. Those for the outside cylinders receive their motion from the Walschaert gear fitted to the adjacent set of inside motion, thus two sets of valve motion work all four valves. The adjacent valve spindles are coupled together by being linked to horizontal levers. A strong box casting supports the main frames between the outside cylinders, and also serves to carry the expansion links and reversing shaft. Wheel and screw reversing gear is used. The inside main rods have open ends with the brasses held by a gib and cotter, and those for the outside rods have solid bushed ends.

The coupled wheels are 80½ in. diameter, and underhung laminated springs are used. Equalizing gear is provided, all the coupled axle springs being connected, those for the rear coupled axle being connected with the springs for the radial box of the trailing truck.

For convenience in making comparisons, the principal dimensions, weights and proportions of the various locomotives have been arranged in the accompanying table.

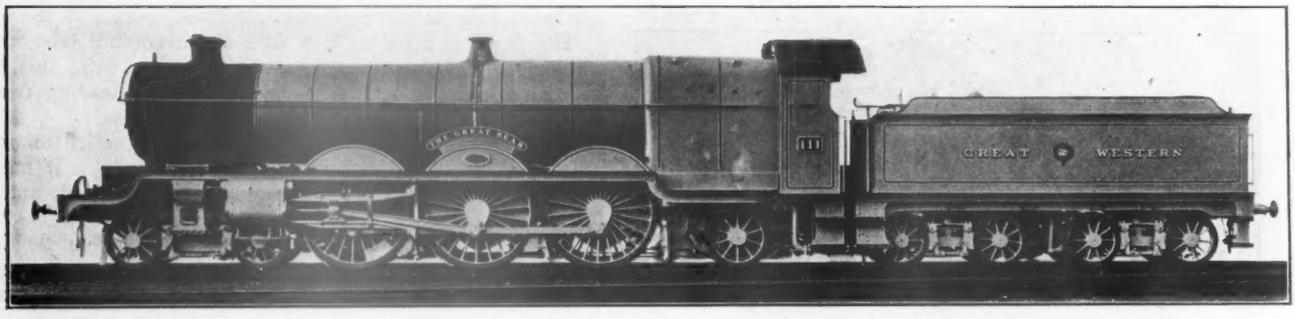


Fig. 12—Great Western, Four-cylinder, 4-6-2 Type Express Passenger Locomotive

Results of Flange Lubrication*

LET us assume that we have before us a section of a locomotive driver wheel tire that has the flange and tread in perfect contour. By removing 1/32 in. from the throat of the flange, 1/16 in. metal would have to be removed from the tread of the wheel to restore the countour, or ⅛ in. from throat eqauls ¼ in. from tread. On many roads this represents considerable mileage lost. If this expense could be eliminated, the cost of maintenance per locomotive mile would be greatly reduced.

An extensive test was made with and without flange lubrication on one of the larger roads covering a period of two years, the first year with and the second year without flange lubricators. The locomotives equipped were run over the same section of the line and everything was directly comparable. It was established on this test when using flange lubrication that the flange wear on the driving wheel tires was reduced 72 per cent, while the wear on the rail per 100,000 gross tons was reduced about 87 per cent. The cost of driving wheel tires per 10,000 miles was decreased 29 per cent, engine truck wheels 42 per cent, and tender truck wheels 49 per cent, with flange lubrication.

In Figs. 1 and 2 it will be seen that without flange lubrication the flange wear was excessive in relation to the tread wear, and that flange lubrication decreased the flange wear, thus allowing the tread wear in a number of cases to be the condemning factor. The mileage made for the flange wear shown is about four times that made without lubrication.

Fig. 3 gives comparative rail wear at the same location and over the same period of time with and without flange lubrication. It will be noted that the wear on the rail with lubrication was about 17 per cent of that on the ones without lubrication. The derailments on a portion of this line over which the above tests were made showed a decided decrease when flange lubrication was used. From actual records taken without flange lubrication, it was found that 80 per cent of the rolled steel wheels under cars and tenders were removed for flange wear.

On the Norfolk & Western without flange lubrication, the front tires of a locomotive averaged 16,000 miles, whereas when equipped with a flange lubricator, they averaged 33,000 miles, or an increase of 106 per cent. The St. Louis-San Francisco showed a net saving of $84.03 per year per consolidated locomotive. The Southern (Queen & Crescent) increased the mileage between turning tires from 23,000 miles before using lubrication to 44,000 miles after using lubrication on the flanges. On Pacific type locomotives the mileage was increased from 40,000 to 92,000 miles.

On a 2-8-0 Southern Pacific locomotive the life of the driving tires was increased 375 per cent when equipped with flange lubricators, the tender truck wheels 436 per cent and

*Abstract of report at Traveling Engineers' Association convention, Chicago, November, 1922.

rail wear on curves greatly reduced. This test was conducted where the ruling grade is 3.8 per cent and maximum curve over 10 deg.

The wide range of opinions of the effectiveness of the

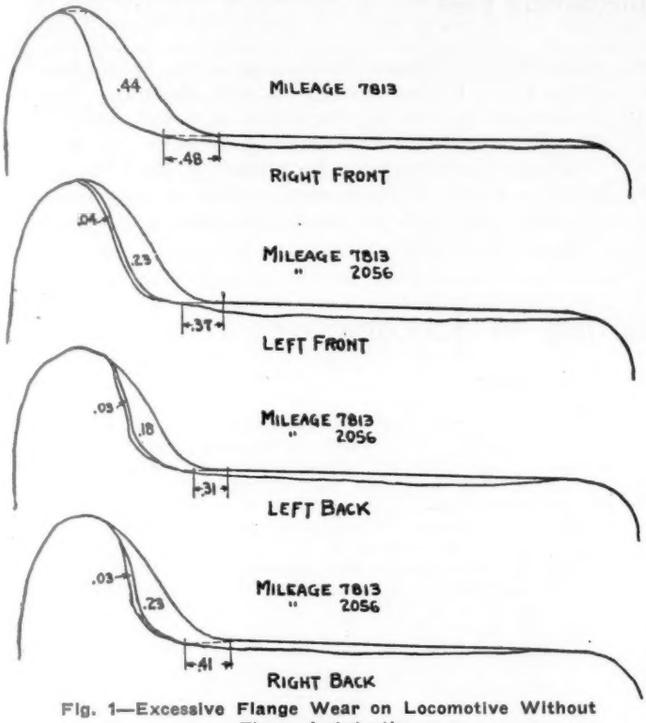


Fig. 1—Excessive Flange Wear on Locomotive Without Flange Lubrication

flange oiler to prevent flange wear indicates that there are certain divisions and certain railroads where their application is justified and where results show a real saving. However, the tractive effort with relation to weight on drivers on certain classes of modern superheater locomotives has been reduced to a point where the application of a flange oiler would result in a waste of fuel caused by locomotives slipping, greater than the saving effected by the use of a flange oiler. With the proper flange lubricator, using a heavy asphaltum oil, the flange wear on the locomotive, tender and cars and the rail wear will be sufficiently checked to warrant the use of flange lubricators, but no matter what flange lubricator is used, it must be maintained and receive the co-operation of everybody concerned.

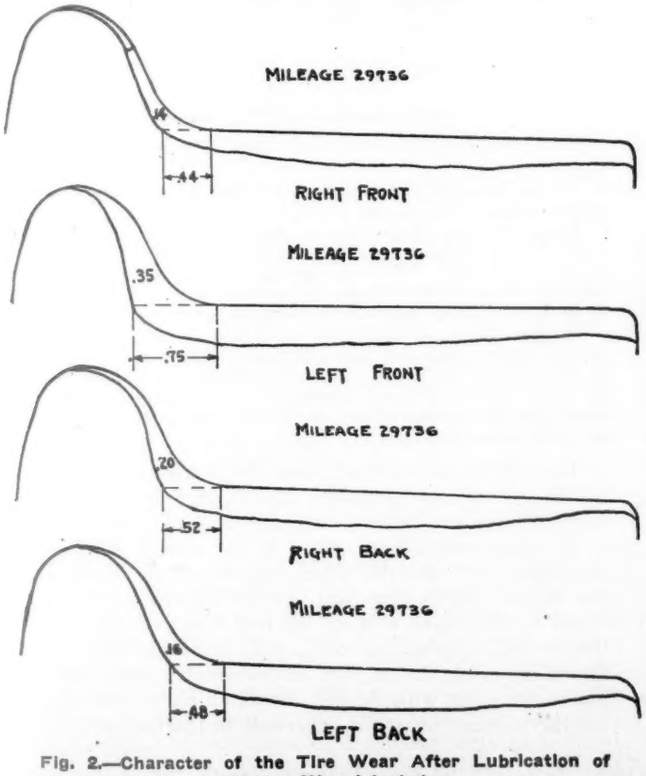
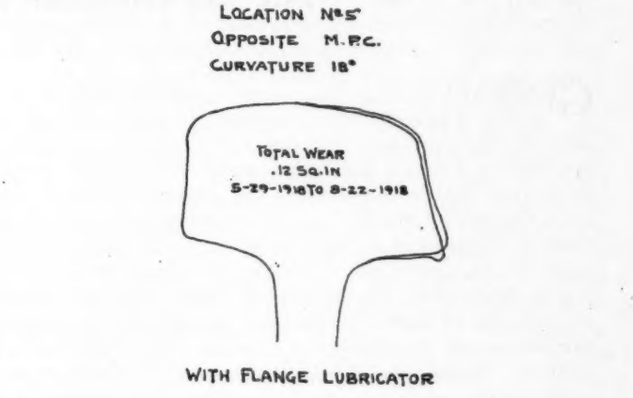


Fig. 2.—Character of the Tire Wear After Lubrication of Flanges Was Adopted

The report was signed by N. Suhrie (Pennsylvania), chairman; J. D. Heyburn (St. L.-S. F.); J. E. Ingling (Erie); P. J. Miller (N. Y. C.), and W. J. Fee (G. T.).

Discussion

From the expression of the members who recounted their experiences with flange oilers, it is evident that wherever operating conditions tend to cause flange wear in excess of



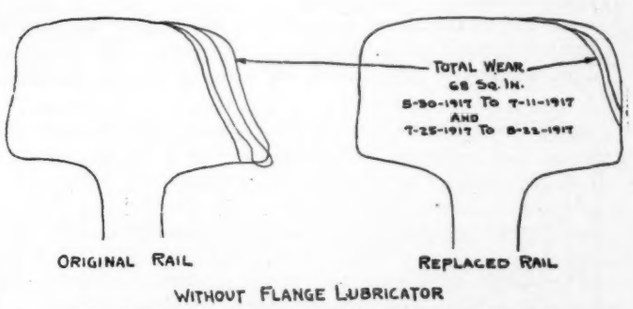


Fig. 3—Effect of Flange Lubrication on Rail Wear

tread wear the service of flange oilers is beneficial. Not only do they reduce the flange wear so that even under most difficult conditions the tires will go for tread wear, but they reduce rail wear on curves and have a noticeable effect in reducing the amount of fuel burned. In almost every case mentioned the greatest difficulty which is encountered in insuring satisfactory service is to secure proper application of the nozzles for the delivery of the oil to the flanges and sufficient attention to maintain them in correct alinement. Where this detail is not attended to oil frequently gets on the tread, where it causes slipping and reduces the effectiveness of the brake action. Several railroads confine the care of flange oilers to one man at each terminal, giving him additional duties such as oiling the spring rigging, in order to fully utilize his time. The tendency in the development of the oiler is to make it automatic and keep it in operation continuously. To this there is some objection on the part of enginemen, who claim that flange lubrication when combined with white frost, fog or drizzling rain, adds to the slipperiness of the rail, and feel that under such conditions they should be permitted to shut off the oiler.

Fan Draft for Locomotives Discussed by A.S.M.E.

Proposed Construction Would Permit Application of Additional Equipment for Saving Fuel

THREE widely different phases of locomotive design formed the topics of the papers presented at the Railroad Session of the annual meeting of the American Society of Mechanical Engineers held in New York on December 6. An extremely technical discussion of Stresses in Locomotive Frames was presented by R. E. Eksergian of the Baldwin Locomotive Works. George H. Hartman gave an analytical discussion of valves and valve gears in a paper entitled "Steam Distribution in the Locomotive," and Frans H. C. Coppus brought out the advantages that might be derived by securing the draft in a locomotive through the use of turbine-driven fans in a paper on Mechanical Drafting of Locomotives. An abstract of Mr. Coppus' paper, which is especially noteworthy because of the possibility of effecting large fuel savings by the method which he proposes, is given below.

The Mechanical Drafting of Locomotives

By Frans H. C. Coppus

GENERALLY speaking, it is a simpler task to incorporate extensive improvements into the design of a new locomotive than to apply them to one already in operation. Though the author would be the last person to discourage the development of the locomotive along radical lines that would require a total reconstruction or rearrangement of the present locomotive power plant, he believes that more can be accomplished for the immediate future by adding to the existing locomotive equipment which is standard, in principle at least, in stationary and marine practice, and which does not necessitate extensive or costly alterations. The existing locomotives, 68,000 in this country alone, represent such a large investment that no matter how efficient a new locomotive may be built, it is out of the question to relegate them to the scrap heap, and they will be with us for many years to come.

In the treatment of this subject the author has therefore limited himself to the existing locomotive. The supporting data employed are based on modern steam locomotives

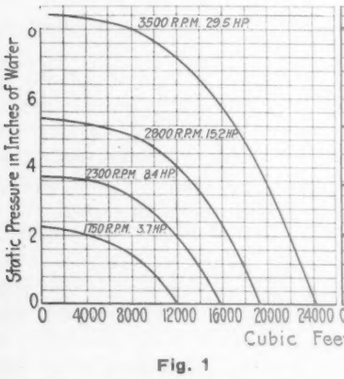


Fig. 1

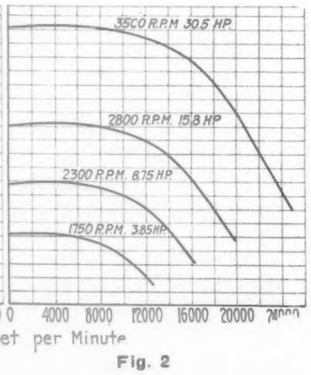


Fig. 2

Fig. 1—Performance Curves of Vano Blower with 22-in. Diameter Diffuser Outlet.

Fig. 2—Performance Curves of Vano Blower with 30-in. Diameter Diffuser Outlet.

equipped with superheater and brick arch and fed by means of a live-steam injector.

History of Locomotive Drafting

An interesting outline of the early history of locomotive drafting is contained in a paper on Locomotive Drafting and its Relation to Fuel Economy, by H. B. MacFarland, presented at the 1912 convention of the International Railway Fuel Association. The following quotations bearing on the subject are taken from this paper:

It is stated, on very good authority, that the exhaust steam from the cylinders was first turned into the chimney by Trevithick in 1803. . . . . He turned the exhaust steam into the chimney as the most convenient way of dispensing with it. Throughout the development of the locomotive to its present high service standard, this method of producing draft has been the only successful one for locomotive service.

Various arrangements and apparatus have been experimented with in an endeavor to secure some method equally as good, but

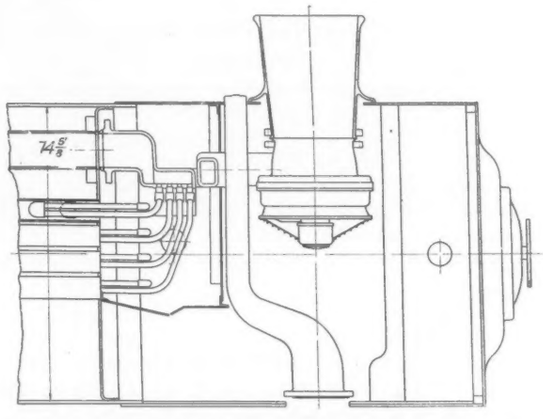


Fig. 3—Modified Standard Front End with Induced Draft Fan

up to the present time nothing has been accomplished which has proven entirely successful.

About the year 1835 Segiun, the inventor of the multitubular boiler, experimented with an induced-draft system, using a fan in the front end. His experiments, however, did not meet with success, owing to his inability to secure a fan of sufficient capacity to properly handle the volume of gases.

Despite the recognized loss of power in the exhaust jet, no serious attempt has yet been made to produce a draft on the fire by other means than the use of the exhaust jet to generate steam to meet the locomotive's demand. All experimental work has been confined to modifications of the general arrangement for utilizing the exhaust jet.

The use of the exhaust steam for drafting the locomotive makes the locomotive power plant differ in principle from the marine or stationary power plant. In the latter the boiler is an independent unit, while in the former the boiler and the engine are interdependent, inasmuch as the exhaust of the engine creates the draft for the boiler and the shutting down of the engine renders the boiler inoperative. Separate the two by substituting mechanical draft for the exhaust jet and there is no reason why the locomotive power plant cannot be fitted out with the devices which have been responsible for the low cost of power generated in marine and stationary

power plants. The problem is one of successful adaptation with reliability and moderate maintenance cost, within the present limitations of clearances and other conditions under which the locomotive must operate.

The logical course of development would be as follows: I, mechanical induced draft; II, undergrate forced draft; III, condensing the exhaust steam; IV, pumping the hot water from the tender through a waste-gas heater into the boiler; V, operating condensing.

Mechanical Induced Draft

About ten years ago extensive experiments with mechanical induced draft were made on the Atchison, Topeka & Santa Fe, but they met with the same fate as those made by Segiun in 1835 and for exactly the same reason: "the inability to secure a fan of sufficient capacity to properly handle the volume of gases." This statement, however, is not exactly correct. It has always been possible to secure a fan of sufficient capacity, but the difficulty has been to secure a fan

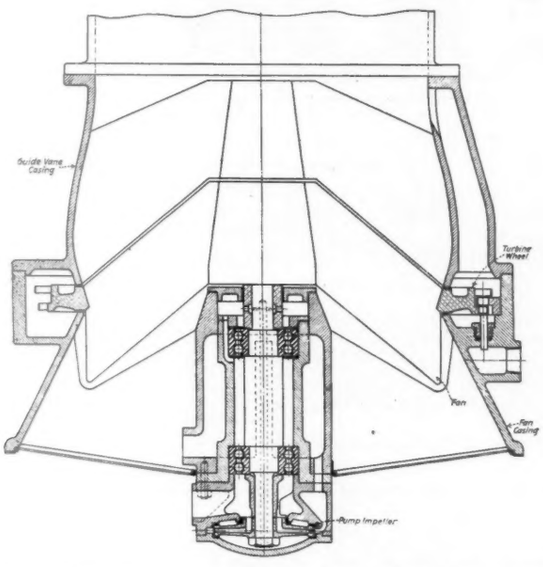


Fig. 4—Sectional View of Locomotive Induced Draft Fan

with sufficient capacity to do the work economically and at the same time small enough to be applicable to a locomotive within the limitations of clearances.

It is doubtful if a fan without the introduction of an intensifying element can be built to overcome this difficulty. Only recently this new element has been brought out. It takes the form of stationary guide vanes held in a casing. The current of air leaving the propeller is radially subdivided by the individual vanes and taken up without shock. These guide vanes, which have a curvature increasing in the direction of the rotation of the propeller, concentrate the air current and give it a further acceleration, so that a large part of the pressure is produced and a large part of the end thrust taken up by them. This new fan or blower is very much smaller than a multi-blade centrifugal fan of the same capacity, both of commercial construction. Because of this fact the former can be made applicable to the locomotive and the latter not.

Due to the fact that this blower has a much larger air delivery than any other fan of the same diameter and that, therefore, the dynamic pressure of the air is very high, the use of a diffuser which transforms the dynamic pressure into static pressure is absolutely essential. The longer the diffuser, the higher the static efficiency. The effect of the diffuser is plainly shown by the curves of Figs. 1 and 2.

Fig. 3 shows the smokebox of a modern locomotive fitted out with a blower in the stack and the exhaust pipe and nozzle displaced by a plain exhaust pipe discharging the exhaust steam into the atmosphere. It will be noticed that the guide-vane casing takes the place of the lower part of the stack, and it may be of interest to mention here that the size of the stack was exactly that of the diffuser of a 20-in. fan which has the proper capacity for this particular engine —a 26-in. by 28-in. Pacific type.

A modification of the fan is necessary in order that it may function properly as an induced-draft blower for locomotives, keeping in mind especially, simplicity of construction; low maintenance cost and assurance that the bearings are kept cool and well lubricated at all times, as the success of the whole scheme hinges not only on the capability of the blower to create the desired draft in the smokebox, but also to stand up under it.

Fig. 4 shows a cross-section of the induced-draft blower. The turbine is located on the periphery of the fan, and therefore takes up little space. The exhaust is discharged with the gases. There is no need of trying to reclaim this exhaust, as there is an oversupply of exhaust steam. The fan shaft carries on its extreme end the impeller of an oil pump which has a manifold purpose. The fan revolving at a high speed, in this particular case about 3,000 r. p. m., creates considerable back pressure, to which is added the weight of the rotating parts. No bearing will stand up under this end thrust at this speed and other means must therefore be adopted to take care of it. The end thrust created by the pump impeller is made use of to counteract the end thrust of the fan. By restricting the pump discharge to the cooling chamber, the end thrust of the pump impeller may be made anything desired, so that the vertical blower shaft may be made to float. The oil then passes upward over half of the cooling chamber, downward over the other half, and out of the smokebox into a cooling coil back to the pump inlet. The shaft is hollow and oil is forced through it and out through a small hole into a chamber over the upper ball bearing, whence it passes through the two bearings and then back to the pump.

One of the outstanding advantages of the use of an induced-draft fan instead of the exhaust jet for drafting the locomotive is the reduction of the back pressure in the cylinders. Prior to the experiments of the Atchison, Topeka and Santa Fe, a series of indicator cards taken from actual road tests of representative locomotives in various classes of service were prepared showing the initial pressure, mean effective pressure, back pressure, and indicated horsepower, and in addition the added mean effective pressure and indicated horsepower which could be obtained by reducing the back pressure to 4 lb. These showed increases in indicated horsepower ranging from 18 to 30 per cent for simple locomotives and an average of 53 per cent for a mallet compound.

The author understands that since these tests were made the exhaust nozzles have been opened up considerably so that the back pressures have been greatly reduced. With this in mind, and also the fact that the back pressures vary so widely for different classes of engines, road, and service conditions, not to mention the enormous differences in back-pressure horsepower due to different speeds, it would be idle to estimate what saving in fuel would result from drafting locomotives mechanically due to reduction in back pressure. However, the field seems broad and the prospects bright for enormous savings along this line.

If the only effect of drafting locomotives mechanically was the elimination of the back pressure on the pistons, this would in itself be sufficient to deserve the keenest interest of those responsible for the economical operation of locomotives, but the subject embraces a great many other questions and vitally affects many features in connection with the economical generation and use of steam. Mechanical drafting gives the locomotive a degree of flexibility which it does not now possess. The steam pressure may be picked up at will

or allowed to drop, regardless of the amount of work the engine is doing.

This flexibility of draft makes it unnecessary to favor the engine at any time. The practice of favoring the engine on hills, often no doubt unavoidable under the present method of drafting, is not only wrong from the point of efficiency but cannot help but result in leaky tubes, increasing maintenance cost, and in shortening the life of the boiler.

The advantages of mechanical induced draft mentioned above largely relate to economy in the use of steam after it is once generated. In addition thereto mechanical draft has a strong bearing directly upon fuel economy and will greatly increase the overall boiler efficiency.

The heat loss due to combustible in cinders, estimated anywhere from 5 to 20 per cent depending largely on the class of service, is generally classed among the "unavoidable losses." With a fan the constant flow of air through the fuel bed, while gradually changing in intensity, will not tear the fire, and this loss can be practically entirely eliminated.

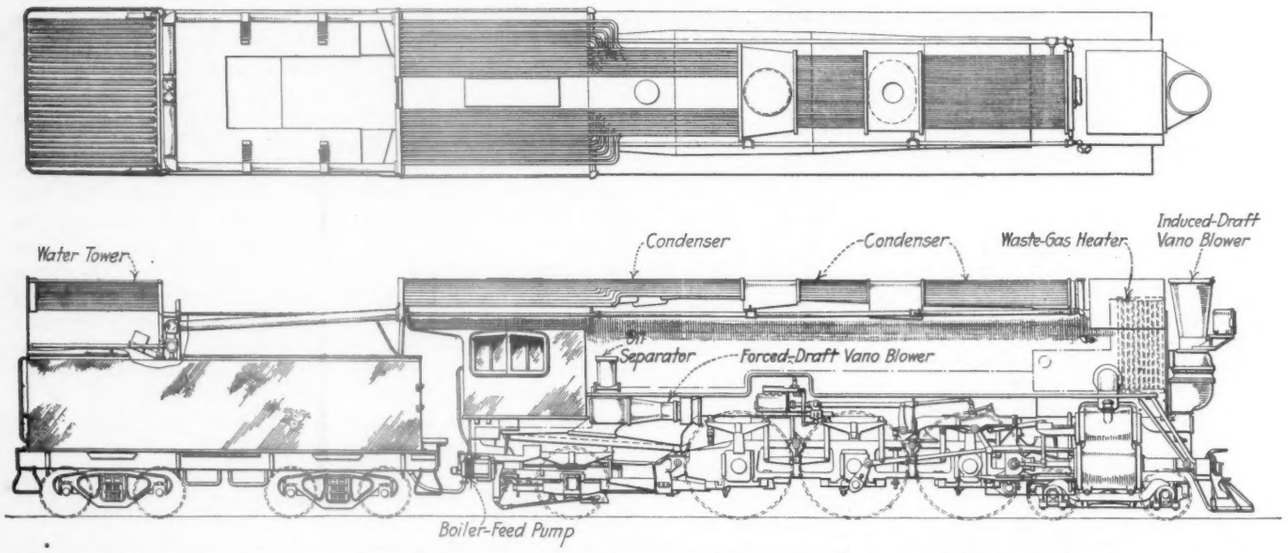


Fig. 5—Proposed General Arrangement of Locomotive with Induced and Forced Draft, Centrifugal Boiler Feed Pump and Steam Condensing Apparatus

Undergrate Forced Draft

To put the ashpan of a locomotive under pressure might prove impractical for several reasons: First, it would be difficult to keep the ashpan even fairly tight; second, there would be danger of setting fires; third, it would decrease the capacity of the pan as there should be ample air space between the ashes and the grate. To overcome this difficulty the author has constructed a grate with hollow bars taking the air from a wind box to which the forced-draft blower is connected.

The forced-draft blower is of the same general construction as the induced-draft blower. It operates, however, in a horizontal position with no excessive end thrust and handles cold air. Therefore, the special lubrication, end-thrust balancing, and cooling features are unnecessary.

While it is not impossible to operate a forced-draft blower in conjunction with an exhaust jet, it is much simpler and better to connect it up to an induced-draft fan. It will be plain that if the forced-draft blower was working alone the combustion chamber would be put under pressure and the gases and flames would leak out through the fire door. If, on the other hand, only the induced-draft blower was working, conditions would be very much the same as they are with the present practice. Between these two extreme conditions the speed of the two blowers could be so adjusted—and after once adjusted, maintained—that there would be an atmospheric pressure condition in the combustion chamber, if carried to a nicety. This is very common practice with stationary and marine boilers. With the fire door open there would be no inrush of cold air nor any outward leaking of flames or gases. Such a condition is called "balanced draft." It can be effected only by the use of a forced-draft blower in conjunction with an induced-draft blower, jet blower, or stack. While in a locomotive boiler there is no boiler setting through which air can filter in, the draft over the fire is so much stronger than in stationary practice and the fire door (on hand-fired coal burners) opened so much oftener, that even greater economies than in stationary practice should result from balanced draft.

With forced draft there is no reason why cheaper grades of fuel could not be utilized, which will not only result in economy in the cost of fuel, but also in the cost of handling and storage of coal. The air space in the grates may also be very small so that no fuel will be lost in the ashpan, and at the same time the grate will let sufficient air through on account of the air being delivered under pressure.

The forced-draft blower creates sufficient pressure to force the air through the fuel bed, leaving only the drawing of the gases through the boiler tubes to the induced-draft blower, and the latter may, therefore, be smaller or may be run at a lower speed than if used alone. For these various reasons it is easier and more efficient to use a balanced-draft system than merely induced draft.

Condensing the Exhaust Steam

When the locomotive is drafted mechanically all of the exhaust steam is available for whatever use can be made of it. Heretofore a small part of the exhaust steam has been used to heat the feedwater. This practice has been quite common in Europe but has been only recently successfully carried out on this continent and to only a very limited extent, less than one per cent of American locomotives being thus equipped. The exhaust-steam feedwater heaters have been constructed on the principle of imparting to the water the maximum amount of heat with the minimum amount of exhaust steam because the latter was needed to draft the locomotive. With mechanical draft, the more steam used for heating the feedwater the better, as the more water will be saved. Railroad men fully appreciate the economy in time and fuel due to the saving of water, especially in freight

service, and incidentally the not negligible economy in boiler repairs in bad-water districts.

The exhaust steam, or as much of it as can be condensed, may be passed through a condenser on top of the locomotive running all the way back to the tender (see Fig. 5). The remainder may be allowed to pass to the air free for the time being. Such an arrangement affords a large cooling surface and the amount of water which can be saved without even attempting to run the engine condensing will be much larger than the amount saved by merely heating the feedwater by means of an efficient heater. The cooling surface may be made more effective by directing over it a current of air created by the speed of the locomotive with or without the assistance of the undergrate-draft blower. It is a simple matter to encase the condenser, provide it with louvers to catch the air, and connect it to the blower inlet by means of a duct. This would have the additional advantage of reclaiming part of the latent heat of the exhaust and supplying the fuel bed with preheated air. A cooling tower located on the back of the tender would further assist materially in condensing the exhaust.

Pumping the Hot Water from the Tender Through a Waste-Gas Heater Into the Boiler

It needs no explanation that with all the exhaust steam available it will be a simple matter to keep the water in the tender at any temperature desired up to the boiling point. This would convert the tender practically into an open heater. Many of the carbonates would be precipitated and most of the dissolved oxygen removed. Instead of the injector a boiler-feed pump, preferably of the centrifugal type, installed in duplicate, will feed the water through a waste-gas heater into the boiler. The pumps will be located under the cab of the locomotive, so that there will be a sufficient head of water from the tender. Waste-gas heaters have been so far a distinct failure largely on account of the prerequisite that

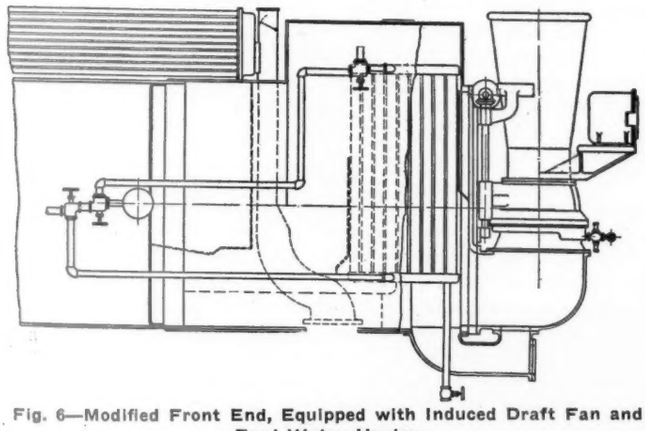


Fig. 6—Modified Front End, Equipped with Induced Draft Fan and Feed-Water Heater

the heater should not interfere with the draft, because if it does the economy derived from its use would be nullified by an increase in back pressure. On account of the limited space available in the smokebox, the heating surface was comparatively small and facilities for examination, cleaning, and overhauling were for the most part lacking. The author has constructed a waste-gas heater which can be placed in the front end with slight alterations thereto, and which has a heating surface of over 1,000 sq. ft. By extending the front end this heating surface could be increased if necessary.

From the point of efficiency it may be considered that at the present time the water is put in locomotive boilers at an average temperature of 60 deg. F. the year round. Although the injector, which is almost exclusively used on locomotives for feeding the boiler, imparts the heat of the live steam to the water, this is accomplished at a loss of heat.

If, instead of an injector, a pump is used the exhaust steam and the waste gases—which comprise the two largest items of waste energy in present locomotive operation—can heat the water from 60 deg. to 300 deg. With an absolute steam pressure of 200 lb. this is an undisputed saving in fuel of a little over 20 per cent, and the feedwater entering the boiler at a higher temperature by 150 deg. will reduce the viscosity and promote the circulation of the water and will have a very beneficial effect upon the cost of maintenance

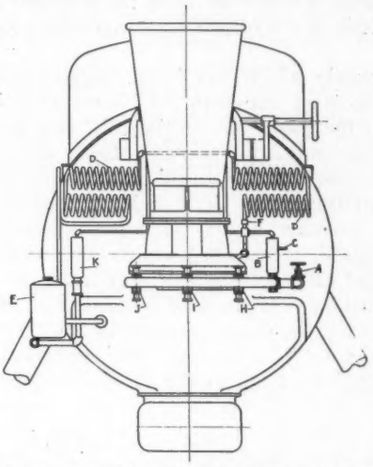


Fig. 7—Front of Locomotive Showing Induced Draft Fan and Controlling Apparatus

and the life of the boiler, as unequal stresses would be practically entirely eliminated.

Operating Condensing

Mechanical drafting of locomotives makes it possible to run locomotives condensing. It can be accomplished without material change in their construction outside of an enlarged and modified tender. This, however, will come later after the steam consumption of the locomotive has been made as small as possible, which will, in itself, make condensing operation easier.

General Arrangement

Fig. 3 shows the induced-draft blower located in the stack. This is naturally the logical first step in the development of an induced-draft system for a locomotive, but a blower in such a position is not readily accessible. Practical considerations led the author to place the blower outside of the smokebox. A diagram showing the general arrangement of exhaust pipe, waste-gas heater, and induced-draft blower is shown in Fig. 6 and will need no further explanation.

Fig. 7 shows a front view of the locomotive. Means are therefore provided whereby the guide-vane casing can be quickly separated from the fan casing, giving access to both the fan and the guide vanes for cleaning.

It will be plain that it is absolutely necessary to have and maintain a fixed relation between the pressure at the grate bars caused by the forced-draft blower and the draft at the front end caused by the induced-draft blower. The steam supply to the induced-draft blower may be taken direct from the steam dome and preferably run through a simple superheating coil in the smokebox extending through the smokebox front into a throttle valve *A*, Fig. 7. Between the throttle valve and the steam chamber of the blower is placed a regulator *B* provided with a lever *C*. When the blower is not in operation this valve is closed, but by pulling down lever *C* the valve is opened, admitting steam to the chamber and starting the blower. The oil pump at the end of the blower shaft circulates the oil through a series of cooling coils *D* into a vented oil reservoir *E*, from which it flows back by gravity into the pump. The oil before it enters the cooling coils passes through a choke *F*, which puts the oil between the discharge end of the pump and this choke under

any desired pressure. To this pressure system is connected a pipe communicating with diaphragm regulator *B*. Therefore, when lever *C* is pulled down, not only is the blower started, but as soon as it comes up to speed the oil pressure which acts against the diaphragm keeps the regulator valve open. If there is no oil pressure, then the moment the operator takes his hand off the lever the valve closes again. Therefore the blower cannot be started nor continue to operate unless there is sufficient oil in the reservoir *E* to supply the pump. This is a fool-proof arrangement against neglect or accident.

The first nozzle which has been supplied with steam is not sufficient to more than run the blower at a speed which will just keep the gases out of the cab, and until valve *A* is shut off at the end of the trip the blower will operate continuously. The main power supplied to the turbine is through automatic regulating valves *H*, *I* and *J*. Suppose in starting off the steam pressure is 200 lb. The blower running at its minimum speed, the steam pressure will immediately begin to drop, and at 198 lb. it will open valve *H* and supply steam to the turbine. If the load is small this may be sufficient to bring back the steam pressure to 200 lb., when valve *H* will close again. Just as soon, however, as valve *H* does not supply sufficient steam to the turbine to keep the steam pressure around 200 lb,. the pressure will continue to drop, and at 195 lb. valve *I* will open. This may or may not be sufficient to raise the steam pressure. If it is sufficient to raise it between 195 and 198 lb., valve *I* will close and at 198 lb. valve *H* will close; but, on the other hand, if it is not sufficient and the steam pressure drops to 192 lb., valve *J* will open. At any rate the steam pressure will travel between 200 lb. and 190 lb. and the blower will be gradually slowing down and speeding up, at all times giving the required draft to maintain a pressure beteen 190 lb. and 200 lb., regardless of load conditions.

The oil pressure also controls regulator *K* and gradually opens and closes it. In other words, the higher the speed of the induced-draft blower or the higher the oil pressure, the wider the regulator is opened. This regulator controls the steam supply to the forced-draft blower and the boiler-feed pump, and also the steam supply to the stoker or oil burner, if used. The oil pressure also controls the supply of oil to an oil burner, so that whatever method for generating steam is used, the induced-draft blower not only furnishes the necessary draft but also controls the amount of fuel used and the water fed into the boiler. The boiler-feed pump is equipped with a combined excess-pressure governor and safety stop, maintaining a predetermined pressure in excess of the boiler pressure at any load from practically nothing to full capacity. Proper provision is made whereby the steam supply to the different apparatus is partly shut off when the engine is standing, or drifting, if the locomotive is equipped with a superheater, to compensate for the closing of the superheater chamber resulting in the greater part of the area through the flues being shut off and which otherwise would disturb the relation between the induced-draft blower and the other equipment controlled by the oil pressure.

Conclusion

Whatever the saving in fuel will be, due to the elimination of back pressure, the heating of the feedwater, the stopping of the waste of unburned coal through the stack and through the grate, the elimination of cold air over the fire, etc., it is going to reduce just that much the amount of coal that is being fired, or the rate of combustion, which in itself greatly increases the boiler efficiency.

A rate of combustion of 100 lb. shows a boiler efficiency of 65 per cent. Reducing this rate of combustion to 60 lb., directly and indirectly by means of mechanical drafting, which is not impossible, the corresponding boiler efficiency would be 74.2 per cent, or a saving of 9.2 per cent.

In a paper presented by John E. Muhlfeld, at the Annual Meeting of The American Society of Mechanical Engineers, December, 1919, entitled Scientific Development of the Steam Locomotive, the following heat balance is shown as representative of locomotives worked at from 25 to 35 per cent cut-off and hand-fired:

	Percent
Heat absorbed by boiler	55
Heat absorbed by superheater	10
Heat loss in smokebox gases	14
Heat loss in cinders	8
Heat loss in vapors of combustion	4
Heat loss in combustible in ash	3
Heat loss in carbon monoxide	2
Heat loss in radiation and unaccounted for	4
Total	100

Under the same conditions but with mechanical draft and the waste-gas heater as described by the author, the heat balance should be approximately as follows:

	Percent
Heat absorbed by boiler and waste-gas heater	74
Heat absorbed by superheater	10
Heat loss in smokebox gases	5
Heat loss in cinders	2
Heat loss in vapors of combustion	4
Heat loss in combustible in ash	1
Heat loss in radiation and unaccounted for	4
Total	100

It does not matter so much what can be done in laboratory tests or even in road tests, when everything is tuned up and everyone is trying to make a good showing, as what actually prevails under ordinary operating conditions, and the efficiency of any equipment which depends upon the intelligence and faithfulness of the operator must be discounted. For maximum efficiency the operation should therefore be as nearly automatic as possible, and in so far as the human element must enter into it, everything should be done to make it simple and convenient for the operator. This is an axiom which the author has kept carefully in mind in the development of the equipment described. Draft is supplied exactly as needed and when needed, and the water is fed through the waste-gas heater in the same proportion as the waste gases pass over the heating surfaces. Therefore, maximum efficiency should prevail. The fireman will have no trouble in keeping up steam pressure while holding the water level constant by simply manipulating a valve in the discharge line of the pump. The engineer can count on full steam pressure regardless of grade, load, or weather conditions, and without the power of his engine being affected by draft requirements.

In conclusion, it may be stated that mechanical drafting of locomotives is imperative for the following reasons:

a It reduces the back pressure to a minimum, effecting a saving in fuel of from 10 to 30 per cent—depending upon the amount of back pressure carried at present and the amount of vacuum produced, if any—or increasing the power of the locomotive in the same degree, especially as speed increases, therefore adding to the hauling capacity or speed of fast freight and passenger engines, producing additional revenue tonnage and also eliminating or lessening the necessity for double-heading.

b It produces an engine that is free-steaming under the most adverse conditions and with all grades of fuel, decreasing liability of delay and saving time and money now spent in changing nozzle tips and experimenting with them.

c It keeps the steam pressure constant, regardless of load, saving steam now wasted every time the safety valve pops and making it unnecessary to favor the engine at any time, thereby saving fuel, avoiding unequal stresses in the boiler and resulting in saving in maintenance cost.

d It increases the efficiency of the boiler and grate by effecting better combustion and eliminating the waste of unburned fuel through the stack and in the ashpan—and incidentally stopping the inrush of cold air every time the fire door is opened—thereby avoiding sudden cooling of crown sheet and tubes.

e It makes possible the use of cheaper grades of fuel, resulting in large economies and in simplifying the handling and storage of coal.

f It eliminates the smoke nuisance in terminals and freight yards.

g It makes it possible to condense from 25 to 95 per cent of the exhaust steam, depending upon the season of the year and the kind of condensing apparatus used, resulting in economy in the cost of water and of maintenance.

h It effects a saving in fuel of 20 per cent by making it possible to preheat the feedwater from 60 to 300 deg. F., and incidentally greatly decreases the cost of maintenance by eliminating unequal stresses caused at present by the great difference in temperatures between the lower and upper portions of the boiler.

i It reduces the rate of combustion, thereby increasing the boiler efficiency.

j It lessens the work of both engineer and fireman, thereby necessarily increasing their efficiency.

Discussion

William Elmer (Pennsylvania System) questioned the desirability of making the boiler output independent of the locomotive steam consumption. To show the great amount of air that it would be necessary to handle with a fan if locomotives were drafted mechanically, he presented figures from test plant trials of a Pacific type locomotive with 27 in. by 28 in. cylinders. This locomotive developed over 3,000 hp., evaporated 65,000 lb. of water and burned 12,000 lb. of coal an hour. The draft in the front end was as much as 18 in. of water. It is difficult to determine the amount of air required to burn each pound of coal, but J. T. Anthony states it varies from 12.7 to 8.7 lb. Assuming an average value of 10 lb. of air per pound of coal and assuming further that a locomotive consumes 10,000 lb. of fuel an hour, the fan would be required to handle 100,000 lb. of air per hour. This would amount to 1,300,000 cu. ft. per hour at atmospheric temperature, and at a temperature of 600 deg., which might be expected in the front end, the volume would be double.

Robert Rennie (American Locomotive Company) stated that a locomotive with 55 sq. ft. of grate area working at full capacity should have a fan capacity of at least 48,000 cu. ft. per min. at atmospheric pressure. Cooling the air before it is admitted to the fan would make mechanical drafting less difficult, but the additional resistance due to any appliance for recovering heat from the waste gases is a disadvantage. He considered that the method of reclaiming water from the exhaust steam would hardly be practical because of the enormous cooling surface required.

W. L. Bean (N. Y., N. H. & H.) called attention to the magnitude of the fuel problem on the railroads and pointed out the desirability of trying such designs as proposed by Mr. Coppus because of the possibility for large savings. He stated that fan efficiency and capacity had been greatly improved since the last trials of mechanical draft were conducted and urged early application of the design put forward after careful engineering investigation had been made.

Dr. W. F. M. Goss discussed mechanical drafting of locomotives by means of a turbo-exhauster. He called attention to the objection of the operation of locomotives in cities on account of the noise and smoke and outlined how these could be overcome by the turbo-exhauster. He stated that the required draft could be obtained with from 40 to 50 per cent of the existing back pressure, and in conclusion expressed the opinion that mechanical drafting had so many advantages that it is likely to come into use soon on the railroads.

R. M. Ostermann (Superheater Company) stated that if it was possible by substituting mechanical draft for nozzle draft to save all or part of the waste heat in the exhaust steam, even greater mechanical complications than proposed by Mr. Coppus would be justified. To obtain the full benefits, it would be necessary to condense the steam, but to add a condenser of sufficient capacity to the modern large locomotive seems a difficult structural matter and the effect upon power and steam economy would be hardly great enough to warrant the complication, especially since there are further thermal possibilities from higher steam pressure and temperatures that can be realized with less space and weight. Disregarding the expediency of condensing the exhaust steam, mechanical drafting assumes a different aspect. Its merits would then be confined to possible reduction of back pressure and increased evaporation per pound of fuel due to improvements in draft. It seems questionable whether much reduction in back pressure could be effected or any marked saving made by the turbine as long as the draft is depended upon to keep the front end clear of cinders. Uniform draft would probably reduce spark and cinder losses, but it could be obtained more readily by a receiver in the exhaust passage.

In closing the discussion, Mr. Coppus stated that his proposal had in some cases been misunderstood due to failure to consider all the conditions set forth in the paper. His conclusions had been based on careful study and he felt certain that they were practical.

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Human Problems of Modern Industry*

The Development of Democracy in Business Is Under Way—It Needs Wise Leadership and Direction

By Samuel O. Dunn
Editor, Railway Age

THE HISTORY of industry and of its relations to the people in the leading countries of the world during the last century, and especially during recent years, presents a strange paradox. The development of modern industry has resulted in a vast increase of production which has enabled every class to esetablish and maintain material standards of living higher than ever were attained by any but a very few in earlier times. It has also made possible reductions of the hours of labor and increase of the hours available for leisure, intellectual improvement and pleasure.

If any man whose life ended prior to a century ago, or even prior to a half century ago, had foreseen this vast increase of production, this great improvement in standards of living and reduction of hours of work, he might have anticipated that it would usher in a golden age of harmony, peace and contentment among men. Quite the contrary has been the result. There never was a time when there were bitterer quarrels or fiercer struggles in industry than within recent years.

They have been waged not only between large industries and their employees, but also between large industries and their customers. Both before and since the war the railways have been engaged almost constantly in carrying on controversies with their patrons regarding rates as well as with their employees regarding working conditions and wages. Almost every large industrial combination also has been the object of attacks in the courts.

These great struggles are being carried more and more into politics. More and more are efforts made to use legislation and government administrative bodies to settle differences arising between large industries and their employees or patrons; and when legislation and government commissions are invoked their tendency is to settle the questions submitted adversely to large industrial concerns.

Finally, growing more and more active and influential is a class of labor leaders, politicians and agitators, who are striving by propaganda, by political action, by strikes and even by violence to overthrow part or all of our existing institutions and to establish in their place institutions varying all the way from a mild form of state socialism to the "dictatorship of the proletariat" in both government and industry as it is exemplified in Russia.

Modern Industry the Cause of Social Unrest

No intelligent man would question the seriousness of some of the struggles between large industries and their employees or patrons which have occurred within recent years. There are those who are convinced that these struggles are direct and inevitable results of the development of modern industry and of the way in which many large industrial concerns have been managed and that unless important changes are made in the managements these struggles will become more frequent, more bitter and more destructive of the welfare of all concerned.

There can be no question about what has been the principal cause of the great increase of production in modern times. Until a little over a century ago there had never been any really great improvement in the physical machinery of industry. Almost all the power used in agriculture, in manufacture and in transportation had been furnished by the muscles of men and animals. It was chiefly the discovery and utilization of new sources of power, mainly steam and electricity, that made possible the development of modern industry. In order to make the best use of these new sources of power large manufacturing and transportation units were created which rapidly drove out smaller ones. Other improvements in the physical machinery of industry, such as those in means of communication, stimulated the tendency of industrial and transportation concerns to increase in size. Owing to these and other causes we have witnessed within recent years the development of concerns which are enormously larger than any which existed prior to a generation ago.

How has this great increase in the size of industrial and transportation concerns helped to create the social unrest and antagonisms which now cause so much trouble?

First, it has tended to put great power into the hands of the managers of large concerns, and it is a law of human nature that men who have great power will be tempted to abuse it to further their interests and the interests of those they represent. There is hardly a large concern in the country that has not at some time and in some ways abused its power in dealing with its employees and patrons.

Secondly, where great power is possessed, or thought to be possessed, people have a tendency to believe that it is being abused, or to fear that it will be abused even though actually it is not being abused at all and there is not the slightest intention of doing so.

The Need of Personal Contacts

The owners and managers of small concerns come into frequent contact with their employees and patrons and therefore know what kind of men they are, and the owners and managers know constantly the feeling and attitude of their employees and patrons and can act accordingly. The owners of large concerns usually are numerous stockholders who are widely scattered and hardly ever come in contact with the employees and patrons. Even the managers of large concerns come into direct contact with only a few employees and patrons. In consequence usually they are almost unknown to the thousands of people with whom indirectly they are dealing; and often they themselves know extremely little about what is in the minds of all these many thousands of people.

If, in addition, as often happens, the principal officers of a large concern deliberately refrain from making any efforts to come into contact with as many of their employees and patrons as they can, or even from making any public statements regarding affairs of the company in which the company and its employees or patrons have a common interest, you have a situation which is certain to beget a lack of mutual understanding which will tend to develop into suspicion, then into antagonism and then into great and dangerous struggles. When the employees and the public begin to suspect, dislike and attack the big concerns in any field the smaller concerns in that field are likely to become the objects of similar suspicion, dislike and attack.

There is not the slightest likelihood of any reduction of

* From a paper read before the Western Railway Club, Chicago, on November 20.

the size of industrial concerns. The most radical advocates of socialism or syndicalism or guild socialism would not favor this. On the contrary, they favor wholesale consolidations of all the concerns in each field and seizure of their ownership by the public and transfer of their management either to the government, or to the employees.

We have recently seen production seriously interfered with by two great strikes due to controversies between employers and employees. We are now seeing the production and commerce of the country limited by inadequacy of transportation. This is due partly to labor troubles but much more largely to years of government regulations based largely on public misunderstanding and prejudice. Bad human relations are tending to arrest the progress of industry.

What is "Democracy in Industry"?

The policy most persistently and persuasively advocated by the critics of the present system is that of "democracy in industry." This is their slogan, although they do not always mean the same thing by it. In fact it is used to mean everything from a mild form of government regulation to the Russian soviet scheme of complete ownership and management by the proletariat. It is absurd to call the Plumb plan and similar schemes plans for establishing "democracy in industry." The Plumb plan provides that the public shall buy the railways and turn them over to the management of those on their payroll. If the railways earn any more than interest on the investment in them, one-half of the surplus will be given to the public and one-half distributed among the employees. If a deficit is incurred the public will pay it all. There never would be any surplus, however, because those in the payroll would fix their own pay through a board selected entirely by themselves. Democracy is supposed to be the rule by the many. Where would be the democracy in an industry which was owned by 100 per cent of the people and ruled by only two per cent of them for their own benefit?

How Shall Democracy Be Attained?

However, one may not be very favorably impressed by the plans for establishing democracy in industry which are advocated by those who seek to overthrow the existing political and industrial order, and may, at the same time, believe that an increase of real democracy in industry is inevitable. In fact, there already have been some great increases of democracy in industry. Labor unions in some industries have acquired so much power that they are able at times practically to dictate their own terms. Witness the recent strike in the coal mining industry and its results. This is one form of democracy in industry, since it involves dictation by hundreds of thousands of employees to a few employers. Our policy of government regulation of railroads affords another illustration of one form of democracy in industry. It involves dictation by the many who use railway service to the comparatively few companies that render it.

The great movement for democracy in government which began generations ago has been resisted to the last extremity by the upper classes in some countries. The results in those countries, of which France in the eighteenth century and Russia in the present century afford the most striking examples, have been tremendous social upheavals in which the upper classes, and, indeed, the entire countries have been almost ruined. In England, on the other hand, the upper classes yielded step by step. Vicious class antagonisms were avoided and under conditions of democracy the property owning and more intelligent classes have succeeded in maintaining their leadership.

Does not this history hold a lesson for the present generation, which is confronted with the insistent demand for more democracy in industry? Does it not suggest to the leaders of industry the wisdom of not resisting all efforts to increase democracy in industry, but on the contrary, of furthering its development along lines which will give employees and the public a larger participation in management and control, while leaving its leadership and direction still in the possession of the comparatively few men of large ability who alone are equal to its leadership and direction?

Employers of past generations took the position—and many take the same position today—that it was their right to fix working conditions and wages in their business, and that labor could accept or go without work. Now, capital furnishes the physical machinery and selects the directing minds, but labor furnishes the manual skill and labor which operate the machinery. There never was and is not now anything unnatural or unreasonable in the desire of labor to have an equal voice with the management in settling terms and conditions of employment relationship. But, if the employees are in any real sense to deal with the management regarding these matters, they must do so through representatives chosen by themselves. This necessarily means some organization of the employees. It is doubtful whether some kind of organization of the employees of any large concern can long be prevented. The question is whether the employees of the individual concerns shall be encouraged to form organizations of their own, or whether this shall be resisted, with the almost certain ultimate result that practically all employees will become members of national labor organizations.

From the standpoint of both employers and employees, dealings between each concern and its own employees are far preferable to dealings with national labor organizations. Only agreements between each concern and its employees can adapt conditions and wages to local conditions with which they are surrounded. Personally I have no doubt that all large concerns should favor an increase of democracy in industry which will result from allowing and encouraging their employees to form organizations of their own and from dealing fairly and frankly with them.

Furthermore, it seems highly probable that most large industrial concerns would derive benefits from encouraging conferences between representatives of the employees and of the managements regarding many questions of operating efficiency. In the long run it is as much to the interest of all to have each concern efficiently operated. About 12 years ago when the record for industrial and railroad accidents was at its worst, many industries, including the railways, organized safety committees composed of officers and employees. There has been since then a remarkable reduction of fatal accidents, undoubtedly mainly due to the work of these committees. There does not seem any good reason why it would not be possible and desirable to form similar committees to bring about co-operative effort to eliminate waste and increase efficiency. There are many employees who could do valuable work on such committees and would not only make contributions toward increased efficiency but also learn some of the difficulties which the managements have to overcome in reducing waste and securing economies.

The Democracy of Ownership

There is another form of democracy in industry which should be earnestly and energetically promoted. This is the diffusion of ownership of the concern's securities among its own employees and patrons. Most large concerns, and especially railroads, are regarded by their employees and patrons as being a kind of alien institutions which exploit those who work for them and from whom they get business in order to pour profits into the coffers of a small class of rich people who do business and live at ease in or within a comparatively small radius of Wall Street. So long as the employees and patrons of a concern regard it thus it will be difficult to convince them that they have any interest in its prosperity. Some concerns have adopted successful means of getting large numbers of their employees to become stockholders.

Some of the best managed public utilities are making successful efforts to get large numbers of their customers to buy their securities and thereby establish what is called "customer-ownership." The best industrial democracy which could be established would be a democracy of ownership. Substantial difficulties would have to be overcome in securing a widespread diffusion of the securities of railways among employees and patrons, but it may be they would not be so great as now believed.

No great result is ever attained without thorough study and great effort being made to attain that result. There has been study and effort to improve human relations in modern industry but the conditions which exist show clearly that it has been far from sufficient. The principle of arbitration of all great controversies that cannot be settled by direct negotiations should be insisted upon; but the thing most needed is the adoption of methods and the creation of a spirit which will tend to prevent the development of controversies to a point where they cannot be settled except by arbitration or strikes.

The Menace of Destructive Propaganda

Without doubt one of the principal causes of bad human relations in industry is that employees and the public have been allowed by the managements to be grossly misled regarding the way in which large concerns really are managed and the profits that are made. Most men who own property and manage commercial and industrial concerns seem to have little idea of the amount, character, or real purpose of the radical literature attacking the present social and industrial order which is being disseminated throughout every country among those who work for wages. Let extensive propaganda go unchecked long enough and it will overthrow any institution. The propaganda to which I have referred, whether carried on by bolshevists, syndicalists, guild socialists, I. W. W. or parlor socialists, is intended to convince people who do not own or manage property that the present system of private ownership and management of large industries inevitably works the enrichment of the few and the impoverishment of the many. It preaches that the many, by forcing the payment of wages which industry cannot stand, or by constant strikes and violence, or by governmental action of various kinds, should indirectly or directly take over to itself the virtual ownership and the actual management of all industries.

This is supplemented by propaganda carried on among small property owners and farmers which attempts to create sentiment against the existing order by greatly exaggerating the profits made by railroads and large manufacturing and mining companies, with the object of causing regulation of their management, their rates and their prices which will help to make private ownership and private management impossible.

Even if all the problems arising from the relationship of employer and employee could be solved temporarily at least there would not long be peace in industry. The present railroad situation illustrates that. The wages of all railway employees have now undergone some, and those of certain classes substantial, reductions, and probably there would be no more serious controversies between the railways and their employees for some time if the present rates were let alone. But already there is a widespread and energetic agitation for further reductions of rates among the farmers. This is partly due to the fact that the farmers really are suffering severely from an unwholesome disparity between the prices they can get for their products and the rates and prices they have to pay for the transportation and commodities they buy, and partly to reckless propaganda which has been carried on to make them believe that while they are suffering losses the railways are guaranteed large profits. If railway rates should soon be reduced again it would be necessary for the railways to start at once to secure further reductions of wages, and then the controversies between them and their employees would begin on a large scale again.

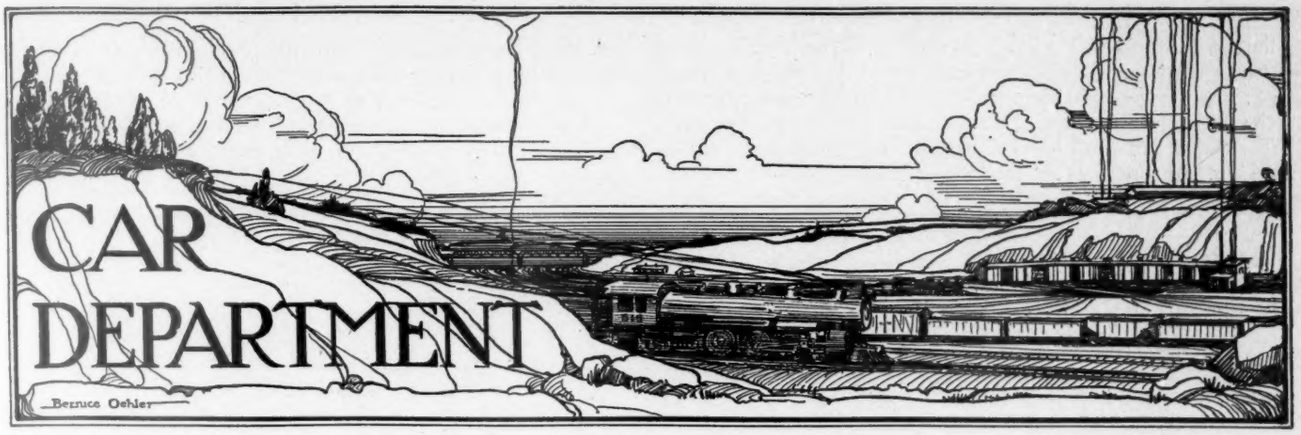
Take the Mystery Out of Big Business

There is a certain large railroad system which from every standpoint is one of the best operated and most successful in the United States. The management has tried in numerous ways to establish close relations with its employees and patrons, and has presented to them by newspaper advertising and other available means the facts about the railroad and what it is doing. It also has been especially prompt and courageous in refuting misrepresentation. When the recent shop employees' strike came this railroad, from the beginning, kept one-half of its shop employees and was one of the first to build up a 100 per cent force. Probably there is no other road which is today more popular and the object of fewer criticisms and attacks. Its management is convinced that the educational work it has carried on among employees and patrons has contributed greatly toward enabling it to maintain its shop forces, secure efficient work, handle a record-breaking business and increase its net earnings.

What the management of this railway has done, those of others can do. With respect to educational work among the employees and patrons of large concerns there are two conclusions I have reached after years of study and observation. The first is that our present system of private ownership and management of large industrial and transportation concerns cannot be permanently maintained without a better understanding and more good will being established between these concerns and their patrons and employees. The second is that the amount of educational work which must be done by such concerns among their employees and the public, if a better understanding is to be secured, must be greatly increased. There are at least a hundred politicians and labor radicals who are actively engaged in carrying on propaganda to secure the adoption of a ruinous policy of regulation and the destruction of private ownership of railroads to every man who is engaged in combating this propaganda. There are scores of radical labor organizations that constantly employ men to deliver addresses and secure publicity in every community in the country attacking private management of railroads. There are hundreds of thousands of railway employees who, under the direction of radical leaders, are everywhere carrying on propaganda against the managements of the railroads. How many of the 20,000 railroad officers make any effort to combat this propaganda?

The Esch-Cummins Transportation Act was passed to destroy the restrictive policy of railway regulation which formerly prevailed, and to establish in its place a constructive policy. Almost from the time it was enacted it became the object of the most false and misleading attacks that political and labor leaders ever carried on with respect to any piece of legislation. At the recent national election almost every important member of the National House and Senate who voted for and defended that law who was up for re-election was defeated, while almost every candidate who made his campaign largely one of attack upon that law was elected. In consequence, there is the gravest danger that the important constructive provisions of the act will be destroyed. If this should be the case the railways probably will have to look for protection to the federal courts.

In the long run the preservation of the present industrial order will depend upon public sentiment. Whether public sentiment in regard to railroads and other large industries will be friendly or hostile, wise or unwise, constructive or destructive, will largely depend upon whether the managements of these concerns make real, persistent and intelligent efforts to solve their human problems. Big business must establish closer relations with its employees and the public and destroy popular suspicions and prejudices by taking all the mystery out of big business or it will have more serious troubles in the future than it ever has had in the past.



100-Ton Gondola Car with Four-Wheel Trucks

High Capacity Experimental Car Built by Pressed Steel Car Company Carries 77.2 Per Cent Revenue Load

ABOUT two years ago the Pressed Steel Car Company built a sample coal car which was designed especially for transporting coal to be dumped in a car dumper and with the idea of carrying the greatest amount of coal on two four-wheel trucks. The car has a stenciled capacity of 182,000 lb. or 3,212 cu. ft. When heaped with a 10 per cent overload, the capacity is 200,000 lb. or 3,703 cu. ft. As the car is always emptied in a car dumper it is not equipped with hoppers or drop doors, being of the flat-bottom, high-side gondola type. The light weight of the car, including the two four-wheel cast steel trucks, is 59,000 lb. although the wear of wheels and brake shoes has, of course, been proportionately greater than on similar cars with six-wheel trucks. The car is reported to have been found satisfactory in all respects. The test shows that it is feasible and therefore more economical to use four-wheel trucks on cars of even such high capacity.

The car is 44 ft. 7½ in. long over striking plates and 11 ft. high from rail to top of sides. The inside dimensions of the body are: length, 43 ft. 3 in.; width, 10 ft. 1½ in., and depth, 7 ft. 5½ in.

Except for the substitution of four-wheel for six-wheel

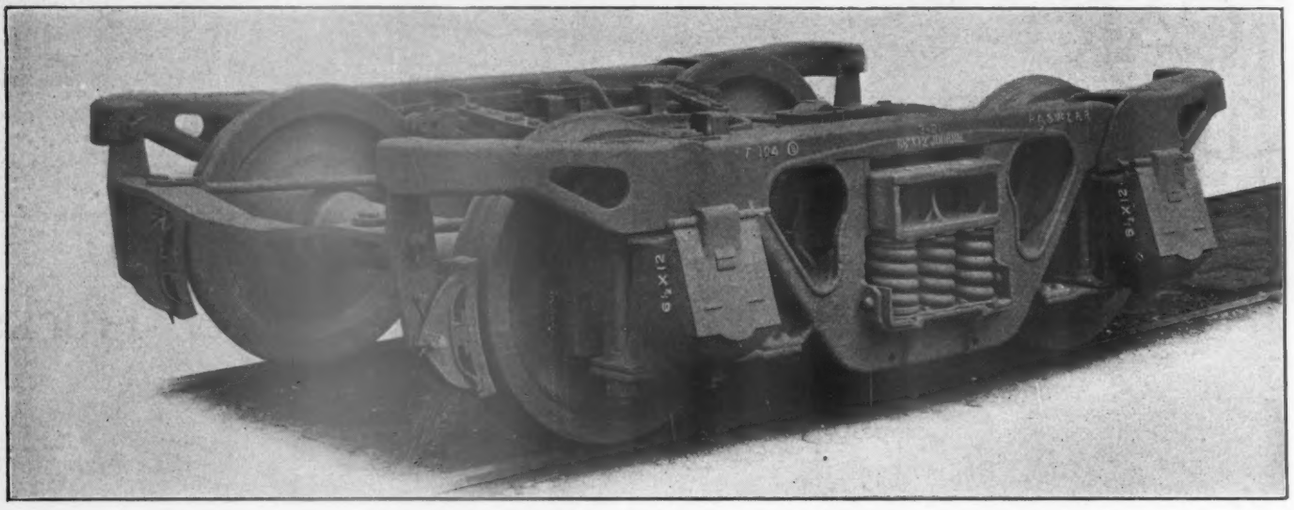
Demonstration Gondola Coal Car of 100 *Tons Capacity*

and when loaded to capacity the wheel-load on the rail, 64,750 lb. per axle, is somewhat less than the maximum allowed for locomotives. These wheel-loads are greater than has been the general practice heretofore and on this account some doubt has been expressed as to the probability of satisfactory operation. This sample car has now been in service on the Virginian for more than a year and has a record of about 10,000 miles in coal traffic. No undue wear has so far shown up on any of the running gear or other parts, trucks, the design is practically the same as that of the 100-ton coal cars used on the Chesapeake & Ohio which were described in the *Railway Mechanical Engineer,* October, 1921. The four emergency drop doors used on the Chesapeake & Ohio cars are omitted, however. In the omission of all bottom doors on high capacity cars designed for unloading by a car dumper, this design follows the practice on the Virginian and the Norfolk & Western.

Of the light weight, 59,000 lb., the body is 35,000 lb. and

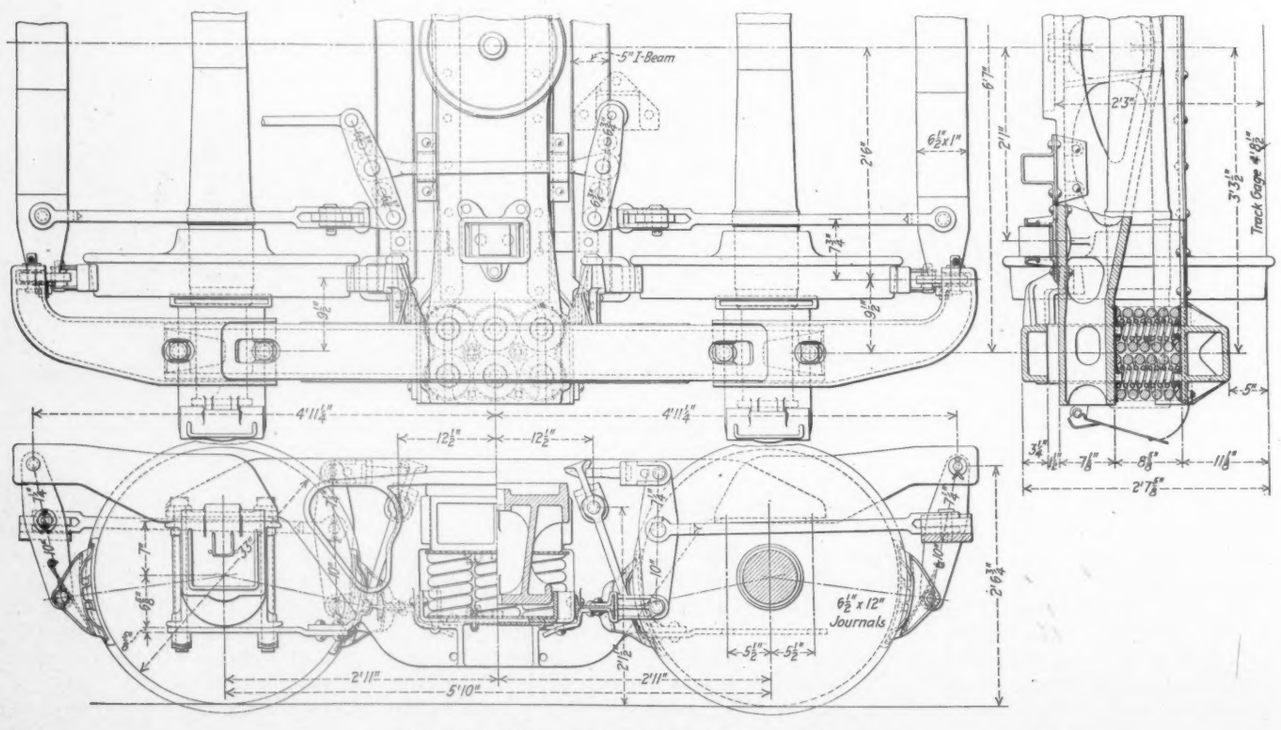
the two four-wheel trucks 24,000 lb. The two six-wheel trucks used on the Chesapeake & Ohio car weighed 33,400 lb., making the light weight 68,300 lb. and the loaded weight 268,300 lb. The ratio of paying load to the total weight of the loaded car was 74.6 per cent with the Chesapeake & Ohio design. By substituting four-wheel trucks, there has resulted a saving of 9,300 lb. per car while the revenue load has been increased to 77.2 per cent of the total.

The sides are free from outside side stakes or other projections outside the plane of the side sheets, thus giving the car a smooth straight surface and at the same time providing for the required cubic capacity in a minimum length and height. The sides are formed of ¼-in. plates, sloped in near the top at an angle of approximately 15 deg. and then flanged out, overlapping the horizontal leg of the 4 in. by 4 in. by 7/16 in. top angle to which they are riveted. With this construction the car is easily cleared of its lading when turned to the proper angle by the dumping machine. Along the bottom the sides are reinforced by 4 in. by 3½ in. by ⅜ in. angles, which angles also support the floor. Near the ends the side sheets are dropped back into the car to provide space for the ladders and grab irons inside the clearance limits, and to afford protection to ladders in car dumpers and elsewhere. The sides are braced on the inside by 11 ¼-in. gussets on each side and are tied together by two pressed steel cross ties extending from side to side near the top. The ends are composed of ¼-in. plates reinforced and stiffened by two pressed steel cross braces and a bulb angle across the top.



Four-Wheel Truck With Cast Steel Frame and Clasp Brake

The center sills are 12-in. channels weighing 35 lb. per foot, spaced 12⅞ in. apart and extending from end to end of the car. They are reinforced at the bottom by 3½-in. by 3½-in. by ⅜-in. angles between the rear ends of the draft gear housings. The sills meet the A.R.A. requirements of

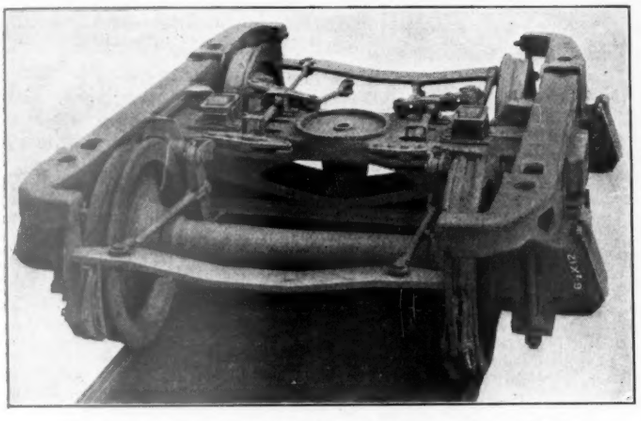


High Capacity Four-Wheel Truck With Clasp Brake

30 sq. in. area and ratio of stress to strain of .05. The center sills are reinforced at the coupler opening with a cast-steel combined striking plate and carrier iron making a substantial arrangement with no chance of the carrier iron becoming loose or the bolt being lost. There are three cross beams in the underframes between the bolsters, made of pressed steel 12 in. deep, substantially reinforced at top and bottom to transmit the load to the sides of the car.

The floor, which is flat throughout its entire surface, is made of ¼-in. plates and in addition to being supported by the sills, cross bearers, etc., is supported and braced by two pressed steel diaphragms and two 5-in. bulb angles. The body bolsters are of cast steel, 30 in. deep, in one piece, located inside the body and securely riveted to center sills, floor plates and side sheets.

The couplers are special A.R.A., type D, cast-steel, with



End View of Truck Showing Design of Clasp Brake

6-in. by 8-in. shank, 24¼ in. long with a 5¼-in. by 6-in. tail, slotted for a 6-in. by 2-in. draft key. The coupler yokes are of cast steel and the draft gear is of the Miner design, type A-18-S.

The trucks are of the standard four-wheel type with cast steel side frames of conventional design. The truck wheelbase is 5 ft. 10 in. and the distance between truck centers is 30 ft. 7½ in. The location of the springs and the method of attaching the A. R. A. standard journal boxes with tiebars, as well as the method of spring plank arrangement, are of the usual design used on practically all modern four-wheel trucks. The cast steel side frame and truck bolster were manufactured by the Buckeye Steel Castings Company, Columbus, Ohio, and are proportioned to the heavy loads imposed.

These trucks are equipped with clasp brakes, thereby avoiding the excessive brake shoe pressures which would have been the case with single brakes for trucks of this capacity. The brake beams are formed of 5 in: I-beams weighing 10 lb. per ft.

The design of the outer brake beam support and the method of attachment to the side frame structure is worthy of special notice. As will be observed from the illustrations, the outside brake hanger bracket at each end of the side frame is a separate casting and is held in place without the use of bolts and rivets other than the bolts which connect the journal boxes with the side frame. The advantage of this construction is that these overhanging parts are separate castings and due to liability of damage in wrecks or derailments, the subsequent loss is not as much as if they were integral with the side frame. It also has added manufacturing advantages resulting in economy of production.

The truck bolsters are of typical Buckeye design with channel section top and bottom members, cylindrical center post and integral center plate. The diameter of the latter is 16 in. and width of bolster at ends is 20 in., with a depth at center of 14 in. The spring plank is of built-up channel section design, 14 in. wide at the center. The web is formed by a plate 14 in. by ¼ in., 6 ft. long, which is riveted to the 3½-in. leg of the 4 in. by 3½ in. by 7/16 in. angles which form the flanges beyond the web plate. At each end the angles are spread to a width of 20 in. to conform to the spring seat construction and width of bolster opening of the side frames to which both the vertical and the horizontal legs of the angles are secured by rivets.

Stucki side bearings with solid rolled-steel roller of 4 in. diameter are mounted on the cast steel bolsters 2 ft. 1 in. to each side of the center line. Special integrally ribbed construction inside of the bolsters is provided to carry the heavy side bearing loads.

The truck springs have a total capacity of 468,000 lb. per car when solid and consist of four nests, each containing six double-coil helical springs similar to A. R. A. Class D springs, but having outer and inner coil diameters 1-5/16 in. and 11/16 in. respectively and a free travel of only 1-½ in.

The wheels are multiple-wear rolled steel, 33 in. in diameter and of standard A. R. A. contour. Journal boxes and wedges are of cast steel. The A. R. A. axle capacity for the 6½ in. by 12 in. journals is 60,000 lb. The load on one truck, in this particular car, was considered 120,000 lb. The area of the center plate bearing surface is 190 sq. in.

The car is equipped with Westinghouse empty and load brake, schedule KDE-4-10-16, having a 4-in. take up cylinder, a 10-in. cylinder for use when the car is empty and an additional 16-in. cylinder for use when the car is loaded. The brake rigging is designed to give a 60 per cent braking ratio on the empty car and 40 per cent on the loaded car. The wheel loads are 7,375 lb. when empty and 32,375 lb. when loaded. With two shoes per wheel the nominal shoe pressures are 2,212 lb. light and 6,475 lb. loaded, which are not excessive.

Height of Standard Box Cars

THE committee on Car Construction of the Mechanical Division of the American Railway Association has practically completed designs for standard box cars of 40 and 50 tons capacity for submission at the next meeting. In the latter part of 1920 inside dimensions for box cars were adopted as follows: length, 40 ft. 6 in.; width, 8 ft. 6 in.; height (minimum), 8 ft. 6 in. With the length and width specified the maximum inside height that can be obtained within road clearances is 9 ft. 3 in. As the committee desires to show designs of cars that will meet the requirements and views of the majority of the railroads as to inside height and which can be used with a minimum of change, the American Railway Association has issued a circular requesting the member roads to vote for the height which they prefer. The circular explains that each additional inch of height above 8 ft. 6 in. will add approximately 70 lb. to the light weight of the car and will also add to the cost.

THE LAST WOODEN DINING CAR on the Pennsylvania Railroad has been replaced by a modern steel car. The new cars, when fully equipped, represent an investment of $38,000 each. If all the Pennsylvania dining cars were in operation simultaneously, 4,236 people could be served at one sitting. This company serves 3,575,500 meals annually, requiring a total force of 1,555 employees. The meals are prepared in kitchens having a floor space of 19 ft. 6 in. long and 2 ft. 6 in. wide, where a chef and three assistants prepare and cook 10,000 meals a day. Approximately 2,600,000 eggs are required every year to feed the dining patrons; also 1,500,000 lb. of fresh meat, 1,300,000 lb. of potatoes, 500,000 lb. of sugar, 5,000,000 rolls, 150,000 lb. coffee and 500,000 quarts of milk and cream.

Proceedings of Car Inspectors' and Foremen's Meeting

Tank Car Repairs—Precautions for Carding and Handling Inflammables—Car Department Apprenticeship System Discussed

A HEAVY program was carried out at the convention of the Chief Interchange Car Inspectors' and Car Foremen's Association, which was held at the Hotel Sherman, Chicago, on November 9 and 10. In addition to the discussion of the changes in the interchange rules, a number of papers were read and discussed with keen interest by the large number of members in attendance, and the convention listened to a number of addresses. A list of these papers and addresses appeared with the discussion of the new interchange rules in last month's issue. Two of these papers with the discussions of them appear below. The others will appear in future issues.

Repairs and Maintenance of Tank Cars

By S. F. Beasley
Master Car Builder, Sinclair Refining Company

The manufacturer of almost every article in the United States is, in some measure, dependent upon commodities transported in tank cars. During the World War our industries were called upon to produce to the utmost, and the enormous production demanded a large increase in this class of equipment. In 1914, there were 38,000 tank cars in the United States, and subsequent to that year, the total has increased to approximately 146,000. It is evident that the major portion of this class of equipment has been built within the last eight years.

The tank car equipment of the country—in which the railroad ownership is comparatively small—is used for the transportation of liquids and solidified oils, the main portion of which is petroleum and its products. Owing to the dangerous commodities transported, the Master Car Builders' Association found it necessary to appoint a committee to govern the design of tank cars. The sole object of the Tank Car Committee of the American Railway Association is to have such cars so constructed that they afford safe transportation under ordinary railroad operating conditions. Such products as gasoline, naphtha, benzine and other highly volatile inflammable liquids must be carried in containers that are practically damage proof against everything but wrecks. The increased stringency of the requirements of the Tank Car Committee of the American Railway Association and the Bureau of Explosives have changed and have improved the previous forms of construction, and the evolution of the tank car very vividly indicates the strong desire for even greater safety.

The reports of the Bureau of Explosives show conclusively that the most dangerous, the most destructive article (from the railway standpoint) that is transported, today, is gasoline. Owing to the dangerous nature of the commodity, it became necessary for the Bureau of Explosives to assign inspectors to educate refinery employees in the proper methods of loading and placarding tank cars, and railroad employees in handling them.

Notwithstanding the fact that a thorough campaign of education has been made, the following data will show that ignorance and carelessness are still a part of the human element to be contended with:

Open Dome Accidents

Total cases reported	26
Deaths	83
Injuries	607
Cases with fatalities	12
Other cases with personal injury	9
Property loss	$1,025,928

Bottom Outlet Failures
(Last four years)

Cases	294	37 per cent of total inflammable liquids
Killed	4	11 per cent of total inflammable liquids
Injured	22	18 per cent of total inflammable liquids
Property loss	$851,219	

Gasoline Tank Car Fires
(1913-1921 incl.)

Cases	300
Deaths	108
Injuries	703
Property loss	$4,030,916

RECORD FOR 1921

Results of tank car fires in per cent of the total for explosives and all other dangerous articles

Property loss	51 per cent
Deaths	84 per cent
Injuries	31 per cent

Results of open dome accidents in per cent of all involving gasoline, up to 1922

Property loss	22 per cent
Deaths	71 per cent
Injuries	84 per cent

It can be seen from the foregoing report that the greater percentage of injuries and loss of life are due to open dome accidents, and it is to be hoped that a more thorough campaign of education will be brought about to reduce such accidents.

The question of maintaining tank cars in as nearly as possible their original first class condition is a very important one, and to that end it becomes necessary that each car, when placed at the loading racks, receive a complete and thorough inspection. In order that this inspection shall be thorough and complete, and that the necessary repairs be properly made, we have found it advisable to sub-divide and specialize the work, training men to become thoroughly acquainted with the requirements of each of the several devices used, so that they can restore them to their original first-class condition.

When tank cars are delivered to our refineries, they are given the usual general inspection. The selection of cars for loading necessitates, first, seeing that the cars are in first-class condition and, second, the suitability of the cars for the lading. There are three features of the tank car construction that must be given very close attention. These are the safety valves, the discharge valve and the dome cover. We have specially trained men whose sole duties are to inspect and repair these parts.

The most common defect existing in the discharge valve is corroded valve seats, dirt lodging under the valve seat, and corroded valve rod fastenings. The most common defects in dome covers are worn or broken threads and defective gaskets.

In testing and adjusting safety valves care should be taken to see that the valve seats are properly ground and proper adjustment made that will cause the valve to pop at 25 lb. pressure. On such cars where the safety valve dates have expired we do not simply remove the safety valves and take them to the shop for testing, but they are replaced with others that have been thoroughly tested and properly ad-

justed. We do not look with favor on the testing of safety valves with the weight or spring lifting device shown in the tank car specifications, for the reason that after such cars carrying inflammables have reached their destination and have been emptied, there is invariably a small amount of the liquid remaining in the car and, during the summer months, pressure is liable to be built up. The testing of the valves with a spring lifting device at such times will not give accurate results as there is too great a liability of indeterminate pressure.

The inspection of the tanks is made by men who are thoroughly familiar with this class of construction, and it is their duty to see that the tanks are thoroughly tight before cars are permitted to be loaded. All air brakes are tested before cars are delivered to the railroads for movement.

In addition to the above, we also have a man whose particular duty is to inspect and maintain draft gears and couplers. The selection and maintenance of a proper draft gear for tank cars is a matter of very much importance. In ordinary commodity carrying cars, the construction allows some flexibility between the parts and the load itself, which is of such a nature that shifting can take place, all of which relieves the car structure of much of the damaging effect of impact forces. In other words, it aids the draft gear in its work of protecting the car. The nature of the lading in tank cars makes the work of protecting the car against this damage more severe, for two reasons: First, the inability of the load to shift and thus absorb in work a part of the energy delivered in impact; second, the great seriousness of what might be considered small defects if found on an ordinary freight car. The container is rigidly attached to the underframe and, when in movement, the car is entirely empty or loaded to capacity, so that no assistance can be given the draft gear in its work of protecting the car by either the flexibility of the structure or by the shifting of the load. In ordinary commodity carrying cars, a few loose rivets may be a matter of comparatively small moment, whereas the same number of loose rivets in a tank car may be the cause of ignition and consequent loss of life and property.

The Committee on Car Construction, of the American Railway Association, has had under consideration the standardizing of a pocket length of 24⅝ in. for all classes of cars. This should be discouraged. The major portion of tank cars are equipped with yokes with a pocket length of 18½ in. and in observing the performance of the two lengths of yokes in service, we find that failure of the yokes with a pocket length of 24⅝ in. are much more frequent than failures of yokes with a pocket length of 18½ in. The longer yoke is also subjected to greater transverse stresses due to the radial action under curving conditions than the shorter yoke, which would tend to produce more failures in the longer yoke. All of these tendencies to failure militate against the safety of the tank and its load.

As the modern tank car is of such construction that it is strong enough to stand any accelerating and retarding force in train service and in ordinary handling in classification yards, little can be gained by adding more metal at certain points where stresses take place. The efforts of the Tank Car Committee and the Bureau of Explosives cannot result in any permanent good until some limitation is placed upon the usage of tank cars in classification yards.

Discussion

T. J. O'Donnell (Buffalo): The tank car question is one of the most vital questions in interchange at the present time. In our district we find a number of a certain class of tanks are giving us trouble, particularly at the bottom rivets and the seam. We might feel it is due to excessive switching or train service. The safety valve is one of the main things we are watching at the present time and the question of testing in interchange is raised. It is very dangerous to attempt to test the safety valve under load, particularly with commodities such as ammonia and others of a similar nature. I feel that our higher superior officers realize this more or less at the present time.

I do not think we have improved any in the last year with respect to placarding, because we have tanks traveling through our district with no semblance of the explosive or inflammable cards on the tank at all. I think we should all consider that it is our duty, as well as that of the agent and the yard master and the checker in the yard, to see that those commodities are protected, when traveling through the country, with the placard on the car, outlining just what is in the car.

Thomas B. Koeneke (Indiahoma Refining Company): Tanks should not be placarded on the metal if they are equipped with a placard board. Our rules now are to equip all tanks with the board. The use of cardboard in place of the thin card is also recommended. If the placard is placed on the tank, it frequently stays on the car, although it might later be filled with some commodity that is not inflammable. Cards placed on the tank will frequently wash off, particularly if it happens to rain after they are put on; and in a great many cases, if the refinery fails to put a card on, that car will travel five hundred miles without a card.

The shipper should see that cars are in proper condition, as well as the railroad inspector who accepts the cars. A great many railroads are not in position or will not undertake to repair these cars. For instance, we recently had a car loaded with crude oil, that was transferred at Texarkana, Arkansas, because it had become leaky. That car was held at the main shops of the road at Tyler, Tex., for about three weeks. They said they could not make the repairs, and sent the car in empty to East St. Louis. The car had six leaky rivets and it took about two hours' time to calk the car after it had been steamed out. As a matter of fact, the car could have been repaired under load, because the rivets leaking were in such a position they would not have had to jack the tank at all. It is satisfactory to move a car in to the owner if the repairs are extensive, because a great many roads are not prepared to repair them, but sending in these minor defects is quite expensive both to the railroads and to the owners.

In the Midcontinent field, we co-operate very closely with the Bureau of Explosives, and do everything in our power to see that these cars are handled properly. There are cases where a few men will make mistakes, and everybody should co-operate to prevent them. If a man loads a car which should not be loaded, and it gets out of the plant, the railroad inspector should take action on it. In a lot of cases he does not. Very frequently, the man loading and the man inspecting are sent to outside points to do duties that are not the same as they are familiar with; one man has to inspect and load a car when there should be a more efficient man for the inspecting alone, but because there are so few cars loaded at that point it would not justify having a complete force there.

Mr. O'Donnell (Buffalo, N. Y.): It might be a good idea for the refinery to send a representative to accompany each car to its destination. We send men with trains of stock and I think that it would be money well invested if a practical expert were traveling with tank cars, so that in every terminal they could watch the cars.

Mr. Koeneke: Gasoline is the commodity which has caused most of the accidents and has been the most expensive in property damage, but a car of gasoline is not worth enough to justify the expense of a man traveling with it. A man can take a stock train and all the cars will go to the same point, but with gasoline, a car goes here and a car goes there and a car goes some place else. If the car is in good condition, there is little likelihood of anything happening unless it is in a wreck or is damaged in switching.

Mr. O'Donnell (Buffalo, N. Y.): The time and money spent by those experts would be paid for with one accident; if they prevented one accident, it would be a mighty good investment.

Mr. Koeneke: That is out of the question, when you consider there are about 75,000 cars of gasoline shipped per month. In the terminals something of that sort could be done, but I do not think following them or riding the train would be very practical. In fact, very few roads will let you have a man ride the train; but in the terminals, one man could do a lot of good.

A. W. Fields (Indiahoma Refining Company): I would like to ask Mr. O'Donnell what trouble he is having with the tanks at Buffalo.

Mr. O'Donnell (Buffalo, N. Y.): We had one of the Class Five tanks that was leaking.

Mr. Fields: As I understand the specifications on Class Five tanks, there are no rivets on them. They are welded and will stand a pressure test of 300 lb. per sq. in. I have only seen about five of them, and I do not know of any that I have seen leaking. We have only a very few Class Five tanks in East St. Louis. Most of those go to the Monsanto Chemical Works and are loaded with chlorine gas.

Thomas O'Donnell (Bureau of Explosives): You find about seventy-five Class Five tank cars in the country altogether, and they are as safe, probably, as it is possible to make a container. They are welded and tested at 300 lb. with a safety valve concealed in the dome, and that valve tested at 200 lb. Under ordinary conditions, one of those cars should never appear on the repair track, as far as the container part is concerned, at least. So I think we do not need to put in much time discussing this tank, which is still under observation as to the type of dome and safety valve. The only thing is that it contains poisonous gas: sulphur dioxide or chlorine.

There is one point in Mr. Beasley's paper which I think we should emphasize, and that is the loading of a tank car. It should not be loaded with inflammable liquid until the outlet cap is hanging loose. That is the only test as to whether you have a tight valve. If it isn't tight, you will discover it before the car is put in transportation.

One of the main troubles we have with tank cars in the St. Louis Terminal District, in the winter time, is leakage from the outlet leg, and that is largely brought about in the cold weather through freezing of the water in the boot. The ice forms on the outlet valve and cap and the bottom will be broken downwards or the valve lifted, or the casing cracked. You probably would not notice leakage of gasoline until this ice begins to thaw or gets shaken loose by vibration.

In the course of a few recent years, I have seen tank cars lose their contents on account of the improper handling of such a leak. Before undertaking to stop a leak of that kind, the car should be hauled some place where there isn't any possibility of fire. The leak at the bottom is slight and you can haul it under careful handling. Then see if the valve cannot be replaced at the top by taking off the dome cover. Sometimes wrapping the bottom casing with burlap and turning steam on it will melt the ice and you can let it out through the cap. But do not take the cap off. If you do, the sleeve will come out and let out the entire contents, unless you have a man at the top to work the valve.

Under the existing conditions, we should not have pasted placards; we should have boards. That is vital at this time. Up to this time, tanks were allowed to retain their placards until cleaned by steam or loaded with some item that does not require a placard, but as soon as the new regulations go into effect, about the first of the year, all empty equipment must have placards removed. You can see the difficulty of removing a pasted placard, and you can see how easy it will be with placard boards. This is going to bring up a question in interchange about the charge for removing this placard, so you men want to bear in mind that this will soon go into effect.

As you know, the valve tests are being postponed until January 1, 1923, so that any tank moving now with the valve not tested may continue until January, 1923, with this exception, that if the car goes on the track for repair, it should be tested. In the proposed revision to the regulations, another vital thing will be that if a car is moving with a test overdue, you will not be required to test that valve on a car that contains a dangerous liquid, but you will have a defect card to take care of such a car, and it will say, "Test overdue," or words to that effect, and the car will be allowed to go on till empty. That is going to be quite a relief where you do not have the facilities, and no matter whether you have or not, it is dangerous at best to test a car with gasoline or inflammable liquid, especially in warm weather.

When you consider that approximately 120,000 tank cars are traveling continuously, I do not think that we can indict the railroads for bad handling. It is true that now and then a car gets away and is damaged, but I find a tremendous improvement brought about by this constant agitation for better equipment, and especially better tank cars. Since 1914, we have practically done away with the head blocks which were in themselves a tremendous loss in tank cars.

Twice during the last 10 days my attention was called to what I consider is an improper method of handling a loaded tank car and discharging it: That is building fires under tank cars of molasses. I do not think that should be allowed anywhere, just because they have no facilities for steaming the car. In one case, they built a fire under a tank of molasses within 15 feet of a car of gasoline; a selfish and, at best, a very dangerous thing to do. I want to call your attention to this in order that we may all help in conserving good equipment and not damaging it by unfair usage.

A. Herbster (N. Y. C.): What is the cause of cracked end heads in tanks? I have seen three in the last year, and none of the cars showed any other evidence of rough handling or rough switching. I would also like to ask how many fatalities or how many accidents have occurred from testing safety valves under load or empty?

The last speaker spoke in regard to removing placards from tank cars when empty. I feel that it is just as dangerous to allow a car to run empty, especially one that has been loaded with gasoline, because we never know how much of a load remains in the car.

Mr. O'Donnell (Bureau of Explosives): Formerly when we had head block end rests, the tank was moving all the time and pounding on these head blocks, and it became dented at both ends; and just where the head is dished, it cracked, as a rule on the inside. For that reason, the specifications for tank cars say that when the tank is re-anchored and the head blocks removed, even when there are no head blocks now, if the heads are less than 7/16 in. the head must be reinforced by steel shoes 3 in. thick at the bottom, where this weakness is known to be. Consequently, if the repairer failed to reinforce the end, this crack would develop as time went on and bring about the condition noted. Another reason is that in dishing the head, sometimes a concealed crack or defect in the metal is more apt to be found where this stress is laid. I have seen only one case of a recently built tank, a Class Three tank, having a cracked head plate.

As to the placards, it is well known that any empty tank car is dangerous; that is to say, it is dangerous to take off the dome and put a lamp in there, because the very fact that it is empty makes a space for the accumulation of gases which may be poisonous or inflammable. The general rule is that on no empty tank car is it safe to take off the dome and put in a light. That should dispose of this question of whether one tank car is more safe than another. We are going to have such a tremendous benefit and speed in the transportation of tanks, by removing placards, that the owners of

these tanks, and in time the shippers, will be glad of the change. When you have a placarded tank you have to place it at a certain part of the train. The yard man does not know whether the tank is loaded or empty, unless he throws rocks at it, and then it is a guess. When placards are on only when they ought to be, we will know that placards stand for a loaded tank.

T. S. Cheadle (Richmond, Va.): We have had a good deal of trouble in our territory the last several years, on account of tanks due for tests passing from one interchange point and being caught at another. In some cases I found the inspector was mistaken and the tank was not due for test. I want to bring up the question of having the date the test expires as well as the date the test was made, appear on the tank. There are five different classes of cars, and I will venture to say you will not find many inspectors who can tell you when the test is due.

Mr. Herbster: May I add that you give the time limit for each type, when it is to be tested thereafter; then no matter how many tank cars you have, an inspector will know immediately the date the test expires and the number of months the tank can run with a new test.

Mr. O'Donnell (Bureau of Explosives): There are five classes of tank cars, it is true, but the four classes only are to be considered, because the other is for the transportation of poisonous gases, and it is covered by special regulations. Class Three tank cars in the transporation of sulphuric acid should, if they remain in that service, be tested every five years; but there isn't anything to prevent this tank being loaded with gasoline in the meantime, where it might come under the ten-year test, and, therefore, you would have confusion. We ought to have faith in that certificate that is stenciled on the tank, unless it is obvious that it has gone over the test or would not stand the test. The owner of this equipment, or some responsible parties have examined the tank and stenciled the date thereon. If the car is in apparent good condition after the test, so far as we know,—the interchange inspector, unless the ten years are up, could not tell what car is meant for a five-year test—he reports the condition of the car. He cannot test it under load. Certainly I would not want him to transfer a load of casing head gasoline if the test is overdue. It is something to be handled like this test of the safety valve, with a defect card and a letter to the owner or the lessee of the tank. I do not believe there is any danger in that.

Mr. O'Donnell (Buffalo, N. Y.): Has it ever occurred to the Bureau that it might be wise to put the date of this test on the bill of lading?

Mr. O'Donnell (Bureau of Explosives): No, I do not think it would be any good whatever. The bill of lading is somewhere in Oklahoma, you would have to transcribe that on to the waybill, and how many of you inspectors have it?

Mr. Davis (Sinclair Refining Company): Mr. O'Donnell mentioned a point that was not brought out in the paper, regarding removing of outlet caps prior to loading. We do that. The outlet cap is removed and is left hanging, and if the valve is defective it can be detected immediately and ground in or a new valve applied.

Mr. Koeneke: Isn't it a fact that all refineries have specially trained men in the inspection of these cars? It might be a good idea for a majority of the railroads, especially at terminal points, to take some pains in drilling one or two men in the handling of tanks. We have a plant located at East St. Louis, and we very frequently make transfers for lines in St. Louis terminals. The Terminal Railroad Association has men who are capable of repairing any tank under load, and we are seldom called upon to transfer for them. When the trunk lines call on us we do not transfer one car in ten. All that is needed is an outlet cap tightened or something like that. Such small things as that, if a man is experienced at all, will save a lot of moving as well as the danger while leaking.

Secretary Elliott (Terminal Railway Association of St. Louis): We handle many tank cars loaded from the Southwest, and there are so many minor defects that if we transferred all these cars, we would have burned the town up four or five times. I think Mr. O'Donnell will agree with me that one of the most dangerous things we do is to transfer tank cars. We have men trained on the Terminal Railroad to make such repairs, who have worked under Mr. Koeneke and under Mr. O'Donnell, until a tank must have something absolutely bursted before we have to transfer. We are asked to have men go around to the different roads to stop leaks on tank cars, and it is really laughable the things we are called upon to do that anybody could do. The men are afraid to go under a carload of gasoline and tighten an outlet cap with a wrench, and they will not take off a cap and put on a new one. It is just because they do not understand the tank cars. If you are having any trouble, train somebody in your terminal to look after tank cars and you will cut down your transfers 99 per cent.

Mr. James (Minnesota Transfer): Mr. O'Donnell, of St. Louis, mentioned the defect card in connection with safety valve tests. Would that defect card, issued when a tank was overdue for test, carry authority for the receiving line to bill the delivering line?

Mr. O'Donnell (Bureau of Explosives): These regulations are to be revised as soon as the Commission passes on them, and details have not been worked out.

Secretary Elliott: They do issue defect cards against the delivering line. That is in the changes in the rules.

F. W. Trapnell (Kansas City, Mo.): We handle a great many tank cars in Kansas City, but we do not have any trouble. I do not suppose we transfer a car a month for leakage. We have men who tighten up the outlet cap and fix the valves; and with any kind of oil that is not explosive, they will calk the rivets.

Mr. O'Donnell spoke about the inspector working on this carding of the car with "inflammable" cards. I find that the car inspector has no knowledge when the routing card says "oil," whether it is inflammable or not. It might be gasoline, it might be fuel oil, it might be a dozen kinds of oil that would not require the inflammable card.

Mr. O'Donnell (Buffalo, N. Y.): When a tank car goes through the yard and it is loaded, it is the duty of the inspector to know whether it has the four cards. He consults with the agent, he determines what is in the car, and we find cars with gasoline with no cards. It is as much the duty of the car inspector to see that car is well carded as it is of the bill clerk or anybody else.

Mr. O'Donnell (Bureau of Explosives): If a car contains inflammable liquids, it is placarded by the loader.

Mr. O'Donnell (Buffalo, N. Y.): I am talking about when the shipper overlooks it.

Mr. O'Donnell (Bureau of Explosives): There is a commodity card on these cars which tells you the name of the contents. I do not agree with my friend from Kansas City that it is just called "oil." If it is called "oil" it is not correct; gasoline is gasoline and is distinct from oil. When you find a shipper in any locality violating conditions like that, just give him a memorandum of it and he will be glad to straighten it out for you.

E. H. Mattingley (B. & O. C. T.): A great deal has been said about the proper method of testing safety valves and the handling of outlet valves and dome covers. The draft gear or the draft sills of the tank car deserve a great deal of consideration, and in handling tank cars we find in a great many cases there is considerable slack in the draft gears, which leads up to damage to the tank head, which Mr. Herbster has brought up. It is just as essential to adjust or remove the slack in the draft gear, in order to protect the car, as to test the safety valve or the outlet valve.

G. Lynch (Cleveland, Ohio): Whose duty is it to apply

and remove the placards—what department of the railroad? I understand from the regulations that it is the duty of the shipper, and it also is the duty of the railroad to see that the shipper has them applied. Is there a penalty for failure to apply and failure to remove, and why is the 29-cent penalty asked for when the car is offered in interchange.

I think the whole thing is a matter for the transportation department and should be handled exclusively by that department, and that there should not be any penalty, when a car is offered in interchange, if it is not a mechanical defect.

Mr. O'Donnell (Bureau of Explosives): It is obvious that the protection of the placard is largely a railroad protection; therefore, the regulation is satisfactory that when the shipper loads a car and it contains an explosive or other dangerous article, including gasoline, that railroad should furnish the placard. Now, the shipper knows his commodity; the railroad does not. He has to make a declaration and he placards the car with the right kind of a placard, and it goes on its way in interchange.

It is of infinitely more importance that the danger signal be on the car than any arrangement for a 29-cent or any other charge, because the object is the protection of life and property. Therefore, in order to make the interchanges take an interest in the thing, this charge was put into interchange rules, and no charge is shown and there is no word about charge in the Interstate Commerce Commission's regulations.

Mr. Lynch: I asked why there is no penalty attached to failure to apply or remove the card. The 29-cent penalty does not recompense and I think it should be removed from interchange rules and a penalty incorporated in the Interstate Commerce Commission's regulations, to place the responsibility where it belongs—at the loading and unloading point.

Mr. O'Donnell (Bureau of Explosives): This regulation is in effect because of an act of March 4, 1908, and it has a definite penalty attached to it. It is reasonable to suppose that you would not want this full penalty attached to a man who left off one placard; but if he left off placards that were contributory to a death he would be imprisoned for 18 months or fined $10,000, or both.

J. J. Gainey (Southern): We have quite a few tank cars through the Cincinnati terminal, and I am a great deal like my friend, Trapnell, of Kansas City. We do not transfer a car a month, and we have little or no trouble at all at that interchange point.

F. C. Schultz (Chicago): The removal of the placards is something that is saddled on the car department that I think is absolutely wrong. They are not in a position to know anything about it. Usually in a terminal like this, the billing is a long way from the car. Of course, in case the car inspector discovers billing which indicates that the car was loaded with explosives, he should check the car to see if it has the proper placards; but to expect the car inspector indiscriminately to check such cars does not work out very satisfactorily.

Chairman Pendleton: I would not think that the inspector would be required to check the billing on a tank car if it is not carded "inflammable" or "explosive"; but if some of the cards were missing, I feel it is the duty of the car inspector to know that the car meets with all requirements.

Mr. Schultz: Where does he get the evidence?

Chairman Pendleton: If it is partially carded "inflammable," he should make careful inspection of the car.

Mr. Schultz: I realize if it had one card on and one missing, that would be notice to him that it was loaded with inflammables and he could then check. Most of the trouble we have is with box cars that have been loaded with inflammables and have the old placards on. My advice is to pull them off.

A. Armstrong (Atlanta, Ga.): We attempted, two years ago, to make the car inspector solely responsible for the placards. We found that at isolated points, where the inspector was perhaps two or three miles from the agent or from the location of the bills, this was next to impossible. So the plan which we are using at the present time, at the Atlanta gateway, is to make it an operating department responsibility. When the checker finds the car improperly placarded he makes a report to the yard master; he, in turn, makes a request on my office for a defect card, this request accompanied by a copy of the waybill. No defect card is issued unless a copy of the waybill is attached to the request. We find this works out very well.

Mr. Straub: Wouldn't it be a good idea to try to create the sentiment among large shippers to remove placards for every shipment? There are many placards that remain on a car for a great many trips. An inspector, when he sees a new defect, is going to take notice of it. The same way with placards.

Mr. O'Donnell (Bureau of Explosives): That is another evil that will have to be taken care of by this proposed change. If you see old placards on a box car, it is the neglect of somebody to remove them when the dangerous lading was removed from the car.

Mr. Straub: Isn't it a fact that these old placards remaining on tank cars cause a great deal of trouble at interchange points, of cars being lost?

Mr. O'Donnell (Bureau of Explosives): No, because at the present time they have to remain on the car until it is loaded with some other commodity or until it is steamed out. This proposed regulation will take care of that.

Mr. Cheadle: The Bureau of Explosives, in my territory, has ruled that both the car inspector and the transportation department are responsible for the application or removal of the cards. The ruling said that "The Car Inspector shall see that the car meets with the requirements as outlined in the Bureau of Explosives circular." Under that ruling, a car inspector is equally responsible with the transportation department.

Box cars should not be loaded unless they are properly carded, but they are. An inspector does not know whether it is loaded with moonshine, or what the load is. Therefore, if the car is placarded he passes it to the next interchange point, believing it is loaded with explosives. Now, if there is a placard missing on one side, it is his duty to notify the transportation department, and they will find out what it is loaded with.

E. J. Lee (Bureau of Explosives): The subject of tank cars was so thoroughly discussed this morning that I do not believe there is a whole lot to add; but there are two things that struck me that I would like to mention, that is, to tell you all that one of the greatest sources of trouble on the tank car is that bottom valve. We have been working on that for a long while, and I think Colonel Dunn threw a bombshell when he said, "Either take that bottom valve off the car or give us one that will work."

The Tank Car Committee has appointed a sub-committee to deal with the bottom valve and the safety valve, trying to perfect some device that will work. I understand there have been 31 bottom outlet valves presented to this committee for test, and they have about 17 on cars that were being put in a service test, and there are three or four of those few that show some signs of being what we are after, so we will have a valve there that will not leak. We hope before very long to have some standard type that we can recommend.

Another thing that hits me pretty close, is the matter of wrecks. Not long ago, I was called out to a wreck where five cars were turned wrong side up on a single track main line, leaking very badly. There were three bottom outlet valves smashed off of two of the cars, broken at the scoring and leaving the inside valve intact; but in some manner the inside valve was cocked up and a stream running out.

When I got out there, 12 hours after the wreck had occurred, I found the train master standing in front of the wreck, waiting for someone to help him. I said, "What have

you done?" He said, "Nothing, only send for you. I have never handled a gasoline wreck before." Well, we walked all over and he said, "What is the verdict?" I said, "There is only one verdict and that is to transfer the cars." He said, "We haven't any pumps or equipment to blow it out with air. Can't we put a cable on and drag them out with this engine?" He wanted to drag those 10,000-gallon tank cars out of that wreckage. There is no question but he would have had a bad fire.

He finally found that the Standard Oil Company had a small portable pump at a town about 100 miles from the wreck, and ordered that pump sent over with a crew of men from the Standard Oil Company to transfer the cars. They got there about six hours after I did. They got the equipment set up and going about four hours after that.

It finally developed that at division headquarters they had a small portable pump that was used in unloading fuel oil and other heavy oil, and we finally got that sent down to the scene of the wreck. When that got going, it was just 24 hours after the wreck had occurred. It seems to me that 24 hours is too long for any experienced foreman to tie up a main line on account of a tank car of gasoline.

We had another case in Chicago that took eight hours to get somebody on the scene to pump the cars out.

The thought occurred to me, why not send out an inquiry to every mechanical department, asking them to ascertain whether or not their wrecking outfits are equipped with pumping apparatus and the necessary piping, or whether it was available in some other department, say the water service department; it does not have to be on the wrecker. When a wreck occurs, usually the conductor wires in and tells what he has on the train. If he has a car of gasoline, throw that pump in, for you probably will need it. Going back to this other wreck where they had five cars, the train master said, "Let's form a bucket brigade and transfer these cars." He had 22 men in his gang, and I said, "With a three-gallon pail, each man in your crew will have to make 666 trips from the scene of the wreck over to the other cars. You are going to waste half and the other half will evaporate, and what are you going to have left?"

A pump, either a hand pump or one that can work by steam or air, is one of the handiest things you can have in your wrecking outfit, and don't try to drag the cars out of the wreck until they are empty.

Mr. Campbell (Minnesota Transfer): Whenever we get a leaky tank car, we switch it out, run it to a track and see if we can repair it or make it safe, and there are very few that we cannot repair. Those we cannot repair under load, we transfer; but we do not average one a month that we have to transfer. We have a pump to pump them out.

A. Sternberg (Belt Railway of Chicago): We are prepared for transferring tank cars. We have a pump placed high above the car and we can pump out 10,000 gallons in two and a half to three hours.

I am glad to hear there is going to be some correction made in the outlet valves. If we can only get something that will not unseat when the cars are handled a little bit roughly, it will be a wonderful thing.

Mr. Mattingley: I move that we extend Mr. Beasley a vote of thanks for his splendid paper.

Motion seconded and unanimously carried by rising vote.

Car Department Apprentice System

By H. L. Shipman

Atchison, Topeka & Santa Fe

The need of competent car department repairers and mechanics was never more apparent than it is today. The only commodity that a railroad has to sell is transportation. The possibility of uninterrupted transportation is entirely dependent upon the condition of the rolling stock. Also this question has to do with the avoidance of wrecks due to burned off journals, draft gear breakages, and such defects.

The procuring of competent car repairers and inspectors is almost an impossibility, hence the necessity of educating men for this work. Many railroads have characteristics or special designs of equipment that should be recognized and understood, both in order to make repairs quickly and in order to bill in case a wrong repair has been made by some foreign road.

The most feasible method of obtaining the men desired is to educate them by an apprentice system. The apprentice system in the car department will educate the men to know the standards of equipment used on their road, will drill them on the Rules of Interchange, and will also make them first-class mechanics. This training will produce better men than can be hired and, as a result, the equipment will be maintained in better condition. Has anyone stopped to figure what it would mean in car days for a railroad to have its equipment in such condition that cars would very seldom have to be bad ordered en route under load? Also, what the reputation of delivering freight on time and without delays would be worth to any railroad? Any railroad is measured by its capacity to handle and deliver transportation on time.

The apprentice system not only produces better mechanics than can be hired, and indirectly, better equipment, but it also cultivates a spirit of loyalty to the company which money cannot buy.

To fit the needs of the coach and the freight car department, an apprentice system for the car department should be divided into two parts: First, coach and cabinet maker apprentices; second, freight car apprentices. Although this subdivision was not made during federal control, it is our opinion it should be made. The internal finishing of coaches demands a skilled mechanic, capable of doing accurate and exacting work. The freight car work does not require the high degree of skill and training of the coach shop, therefore, it is not necessary to spend the time in training the freight car apprentice that is required to train the coach carpenter apprentice.

The coach carpenter apprentice should serve a four year course, the same as all the mechanical trades. The time of the freight car apprentice should be shortened to two and a half years.

There is one other distinct difference in the two trades aside from that of skill and that is the physical strength required to perform the two classes of work. The cabinet maker apprentice does not have the continuous heavy work of the freight car apprentice, therefore, the age limit of the cabinet maker apprentice should be the same as the mechanical trades, namely 16 to 21 years of age at entrance, while the freight car apprentice should be from 18 to 25 years old.

The proper selection of apprentices is a very important matter and should be left to one who is a good judge of human nature, aside from any mental and physical examination that may be given. The character of any structure depends largely on the quality of the material that goes into it. There are many characteristics that should be noted in these boys before they are hired as apprentices. Among the most important are honesty, morality, tact, initiative and industry. This is a life work for which the boys are to be trained and, therefore, a careful selection should be made.

All boys entering an apprenticeship should be able to add, subtract, multiply, divide and work simple and decimal fractions. Any boy who has reached the age to enter an apprenticeship and cannot do these simple problems, lacks either mentality or ambition.

Occasionally a boy's traits are not sufficiently developed to determine his fitness, and he may have entered a course for which he has no talent. In order to allow for the possibility of such errors, a six months' probationary period should be established, wherein the boy is carefully watched by a board composed of the general foreman of the depart-

ment, the department foreman, the gang foreman, the shop apprentice instructor and the school instructor. Each month this board has a session in which they consider the progress of each boy in his probationary period. If it is determined that a boy is not fitted for the trade he has entered, he should be dismissed from the service and told to hunt some other class of employment for which he has a greater liking. In doubtful cases, a boy's probationary period may be extended by the board. In any case, the boy knows and his parents know that his dismissal is not due to the spite or grudge of any foreman, but to his lack of aptitude or application.

The training of the car department apprentices might be considered under two headings: First, the shop training of the coach and freight car apprentices; second, their school training.

There should be a shop instructor appointed for every 25 or 30 boys in the shop. It is the instructor's duty to take charge of the boys in the shop and teach them their trade. The coach carpenter apprentices should be given nine months in the cabinet shop, nine months on outside coach body work, nine months on inside coach finishing work, six months on trucks, platforms, piping and steel work, six months in the freight car shop, and the last nine months back in the cabinet shop. Every variety of coach building work should be given them, the schedule of work changing to meet the changing conditions. As the needs of the company change, so should the definite work given these apprentices be changed.

The aim should be to make them broad men, and upon graduation they should be assigned to some particular class of work for which they have shown a peculiar adaptability and upon which they will soon become experts. These apprentices have had a sufficiently broad experience so that in later years they should make good foremen, if their other qualifications are such as to entitle them to promotion.

The shop training of the freight car carpenter apprentices should give them a thorough experience, first on body work of freight cars requiring light repairs, then on trucks, steel work, air, and then back again on the body work of cars undergoing heavy repairs. They should be of more mature years than the coach carpenter apprentices and started at approximately a helper's rate of pay. This rate of pay should be advanced every six months, the same as the coach carpenter apprentices.

The school work of the coach and freight car apprentices covers about the same general ground, except that the course of the coach carpenter apprentices should be more extended, due to the longer period of their course. The school rooms should be equipped and maintained by the railroad company. These schools should be in charge of technically trained men who also have a knowledge of the trade. In these schools they are taught to read a blueprint and make working sketches. All carpenter apprentices should be taught the fundamental operations of arithmetic, including fractions, and how to solve problems in board measure, how to make out a bill of material, and how to estimate the cost of various jobs. The freight car carpenter apprentices, in addition, should be taught the Rules of Interchange. All the instruction of the school should be individual. Each boy can then progress according to his ability.

The leading factors in the success of an apprenticeship system are: First, the unlimited support and backing of the management; second, a competent supervisor who will have entire charge of apprentice matters; third, skilled shop and technical school instructors, and fourth, suitable accommodations for the school instruction, provided by the company.

Any apprentice system thus installed and managed will be a paying investment not only from the shop standpoint, but also in the better service obtained from the equipment. The value of having a body of trained employees working for a railroad company cannot be measured in dollars and cents. Intelligent, skilled workmen, good inspectors and efficient foremen are a great asset to any railroad. The best way to procure them is to educate them by an efficient car department apprenticeship.

Discussion

Mr. Cheadle: The paper is evidently based on a large shop. My experience has been that many car men originate at small points. Then from time to time they get "town notions" in their head, and get the ear of a general foreman and he gives them a chance to come in to the shop as a mechanic.

The system outlined in the paper, if carried out, would accomplish just what is intended. We have a big problem to educate car men. We all realize how hard it is for us to educate ourselves, so we know it is hard for the other fellow to educate himself; he first has to have the desire to know the subject. My experience has been that to select an apprentice in the freight car department, first employ the man as a helper and if he develops qualifications then give him a show. The general foremen and the men who hold the most responsible positions are developed from men in the passenger car craft. For that reason, the schedule laid out for passenger car apprentices would certainly accomplish what the paper says could be accomplished.

E. H. Hall (Pere Marquette): We all know what it has been to educate the employees of the car department, especially apprentices, under the so-called "National Agreement," under which we were prohibited from training car men. The apprentice system outlined in the paper will add to the success of the operations of any shop.

The apprentice is badly needed at this time. We recently have recognized that fact in the present crisis, where we have had to take into the shops inexperienced men to carry on the work that was formerly carried on by mechanics with years of experience. The apprentice boys should be given every consideration that can be given, for the wonderful work they have performed during the past few months.

We had one experience where we were called upon to make some conversions in certain passenger equipment. One in particular was with a parlor car which we had to change into a club car with a smoking compartment. If it had not been for the apprentice boys who supported the railroad, possibly that car would have been in the shop today. Those boys, under a competent instructor, made these conversions, applied the panels and other cabinet work, and when that car went out it was in just as good condition as if a first-class mechanic had done the work; it was better than some mechanics would have done. Four apprentice boys performed this work, three of them with only two and a half years' experience in the coach department, and the fourth one just finishing his fourth year.

I do not think there is anything we could do that would be more beneficial than to take an interest in the apprentice boy, teach him and have patience with him. There are a number of railroads today that have an opportunity to work more apprentices than they have been able to work under the National Agreement.

I had an opportunity a few months ago to visit the shops of the Santa Fe at San Bernardino, Cal. It was wonderful to see the work they were accomplishing with inexperienced men, who had never seen the inside of a coach before and had only been there 30 days. Much of the success of their work was attributed to the apprentice boy who came back and worked in these shops and was willing and did step up and teach the inexperienced man who was hired as a mechanic, to do the work.

Everything should be done to encourage the apprentice system, and the instructor is the vital part of the apprentice system, to teach the boys and get their co-operation, which in the end will mean success to that shop.

Secretary Elliott: I certainly must agree with Mr. Hall. The Terminal Railroad is a switching line and we do not

have the same opportunity to train an apprentice, on account of the character of work we perform, that you do in railroad shops. However, we were requested by the Railroad Administration to try out the apprentice system, and on the class of work we had, we started out something like 15 apprentices. I have six of those boys left and we found in taking our freight car work as it came, steel car work, framing, etc., those boys could do nearly as good work as any mechanic.

The thing Mr. Hall lays the most stress on is competent instructors. We found we were not getting any results from those boys at all, for the reason that the men themselves did not care to encourage them. So the foreman got out and encouraged the boys, and the result was we made nine dandy chaps. Two of those boys are as good as any mechanics we can hire. We should continue each year to encourage the railroads to promote the apprentice system.

One trouble we found was that the boys were rather light for our class of work. You cannot start them on the heaviest class of work and expect the same results you get from a strong man; you have to pick the work a boy can do until he grows up. Unfortunately, in the car department, we have very heavy work, and it takes a mature man to do it.

Mr. Hall: I recently had a time limit to get some mail cars out of the shop to conform to the Class One postal car regulations. We put two apprentice boys on the job, and they actually performed 50 per cent of the work, so far as following the prints was concerned. I have five other apprentice boys who have only been in the service about three months, and those boys do all the sash and door work. A short time ago we put them on some inlay work. We gave a boy the door and panels to inlay maple in the mahogany, and he made a perfect job of it. You could put the job that was performed by the mechanic next to the apprentice boy's job and you could not tell the difference. It was because he was interested and paid attention to the instructor.

C. J. Wymer (C. & E. I.): I am sorry to say that we did not find much loyalty in these apprentice boys, and since the war came on we would just about as soon have a farmer come in as anybody else. We have men who have had no previous experience but were more or less handy with tools, and the results we are accomplishing are in excess of what we got from the trained men we had before.

I believe the apprentice system is all right, especially where there are large shops in which an organization can be created in line with the plan set forth in the paper. A great many roads could not carry on such an elaborate system, on account of the overhead expense involved, but the Santa Fe, being a large system, can enter into those things more readily and in a better form. In a coach shop where fine mechanics are required, apprenticeship is very desirable; but when it comes to freight car work, I am inclined to believe that the old method of hiring helpers and training them until they are competent is about as good as any.

Chairman Pendleton: I agree with Mr. Hall and Mr. Elliott, that the main point is for the instructor, to get the boys interested, to handle them properly. Then there is no doubt you will get results.

Mr. Harring: My observation has been that it is going to be very difficult to get boys to start an apprenticeship in the car department. When you find a boy who will begin an apprenticeship, in nearly every instance he will go into the metal working crafts.

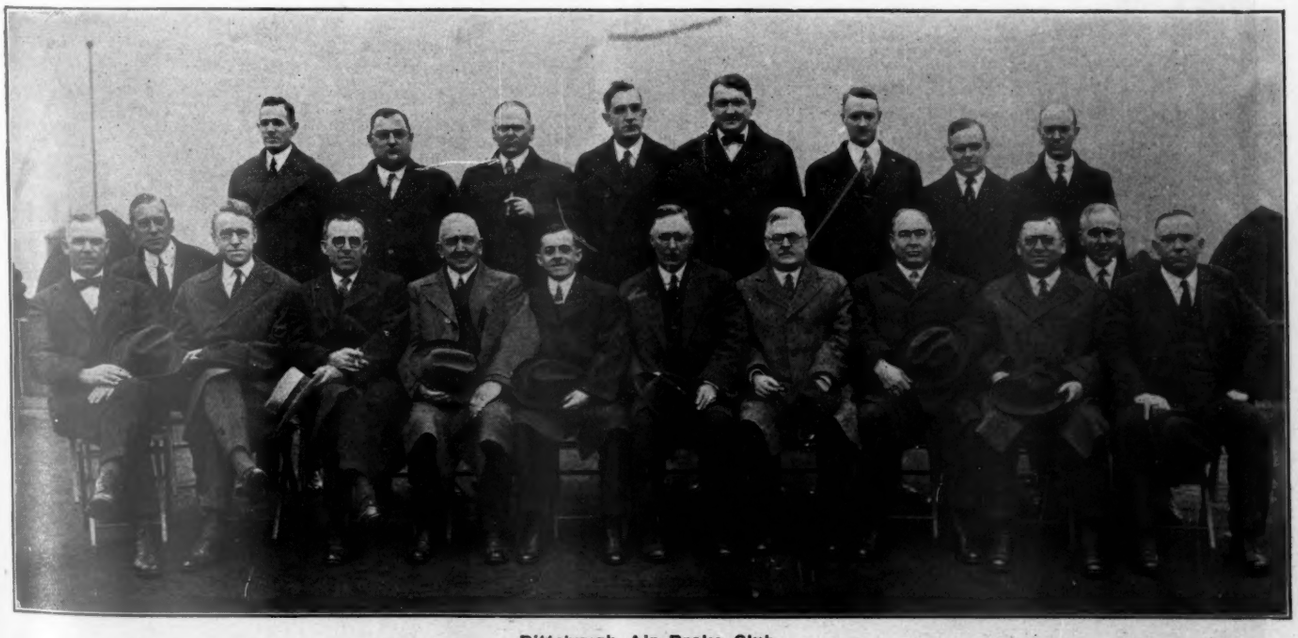
Mr. Goodyear: We are all boys, just overgrown boys. I have been working on apprentice boys for quite awhile, and the only manner in which I could ever handle them was to get down and be a boy with them, get their confidence and give them my confidence, and then work together.

You can never take a boy off freight car work and put him on passenger work and then make a successful freight car man out of him. If you put a man on as an inspector he will never again do you any good as a passenger car man.

Mr. Wymer: We once had an apprentice system but we have none now. We had trouble getting men to take it up. Under the old arrangement of the National Agreement, the helper did not have much opportunity to learn. But fortunately now our railroad has helpers who are real helpers. We have young men, bright and capable with tools, who are employed as helpers. They have supplied themselves with tools and fitted themselves to do all classes of work, looking forward to the day when they will be mechanics.

Secretary Elliott: I move you that the paper be incorporated in the proceedings of this meeting, and that the author be extended a vote of thanks for his very able paper.

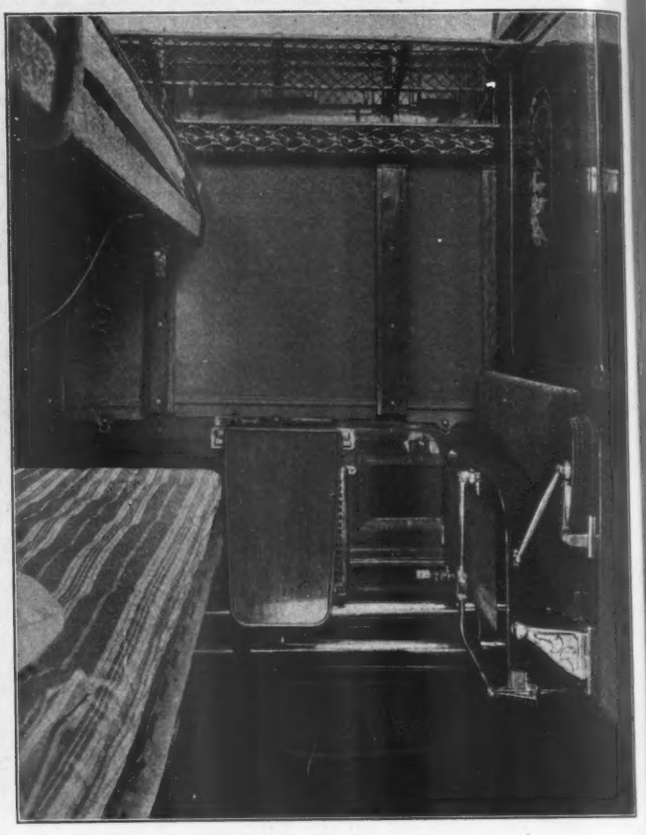
The motion was seconded and unanimously carried.



Pittsburgh Air Brake Club

Seated—Left to Right—R. I. Cunningham, W. A. B. Co.; R. W. Williams, W. A. B. Co.; F. W. Pennington, W. A. B. Co.; W. A. Jex, T. & O. C. Ry.; R. W. Long, P. & L. E. Ry.; L. G. Plank, Penna. System; J. W. Walker, Penna. System; F. H. Parke, W. A. B. Co.; W. W. Shriver, B. & O. Ry.; J. M. Denser, Penna. System; Bert Hyanes, N. Y. A. B. Co.; Harry Sneck, B. R. & P. Ry. Standard—Left to Right—F. C. Young, W. A. B. Co.; Ralph Wolfe, N. Y. C. Lines; W. R. Garber, K. & M. Ry.; C. T. Jackson, N. Y. C. Lines; A. L. Berghane, W. A. B. Co.; W. M. Nelson, B. R. & P. Ry.; E. H. Weaver, W. A. B. Co.; G. A. Stenson, W. A. B. Co.

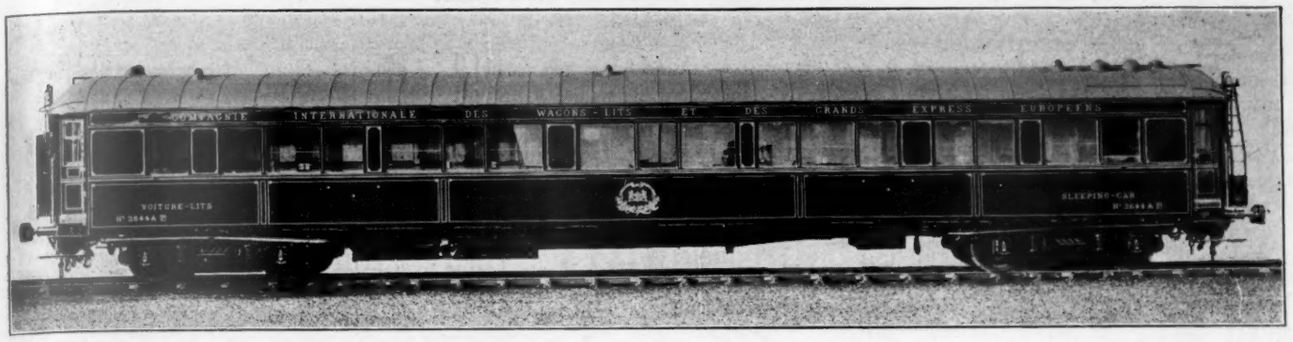
Double Compartment, Looking Outward



Compartment with Two Berths

Double Compartment, Looking Toward Corridor

View Along the Corridor



All-Steel European Sleeping Car Built by Leeds Forge Company, Ltd.

New Cars for International Sleeping Car Company

Leeds Forge Company Build 40 Steel Cars of Interesting Design, Handsome Appearance and Increased Comfort

THE cars of the International Sleeping Car Company (Compagnie Internationale des Wagons-Lits et des Grands Express Europeens) are operated over many different railroads in France, Belgium, Germany, Austria and other European countries. Owing to the different requirements of the various lines in regard to couplers, brake systems, heating systems, signals, lamp brackets and other details and the fact that the runs are frequently long and cross the borders of several countries, the design of the cars necessarily is a much more complicated matter than would be the case were they to be operated only in a limited area.

The Leeds Forge Company, Ltd., of Leeds, England, are now completing the delivery of 40 new cars to the International Company. These are the first all-steel sleeping cars to be used in Europe and the longest and heaviest coaches ever built in England. In general appearance, beauty of interior finish and arrangements for the comfort of the passengers these cars are particularly noteworthy.

General Arrangement

The cars have been designed to carry 16 passengers in eight one-place compartments and four two-place compartments, six of the one-place compartments being provided with communicating doors capable of being locked from either side. The seats turn over to form the bed, the bedding being secured to the underside of the seat in dust-proof containers. The seat back of the two-place compartment is arranged to lift to a horizontal position to form an upper berth, being supported by pull-out brackets fixed to the body side and corridor partition and by safety straps suspended from the ceiling. The two-place compartments are each also provided with a tip-up seat at the window side and opposite to the main seat, a folding table being fixed to the body side between.

In the first six cars, which were for use on the Peninsula and Orient Bombay Express service of the Paris, Lyons and Mediterranean between Calais and Marseilles, the two-place compartments were fitted with corner wash basin cabinets instead of dressing rooms as provided in the remaining 34. These dressing rooms, of which there are two, are arranged one between each two-place compartment and are provided with locks operating simultaneously on the doors leading to each compartment. A porcelain wash bowl is fitted, both hot and cold water being provided, also mirrors, decanters, drinking glasses, brush boxes, towel rails and soiled towel baskets. The window to the dressing room in the corridor partition is of obscured glass of St. Gobian pattern. The interior of the dressing room is finished in white enamel, all metallic fittings being silver-plated.

Each single compartment is provided with a wash basin cabinet, the basin, which is of the tip-up type, being white-metal, silver-plated, as is also the casing. Hot and cold water are available at each basin. A hinged table forms the front of this portion of the cabinet. The upper portion of the cabinet forms a cupboard for the decanters and drinking glasses and the lower portion contains the chamber utensils.

The leading dimensions and weights of these cars are given in an accompanying table.

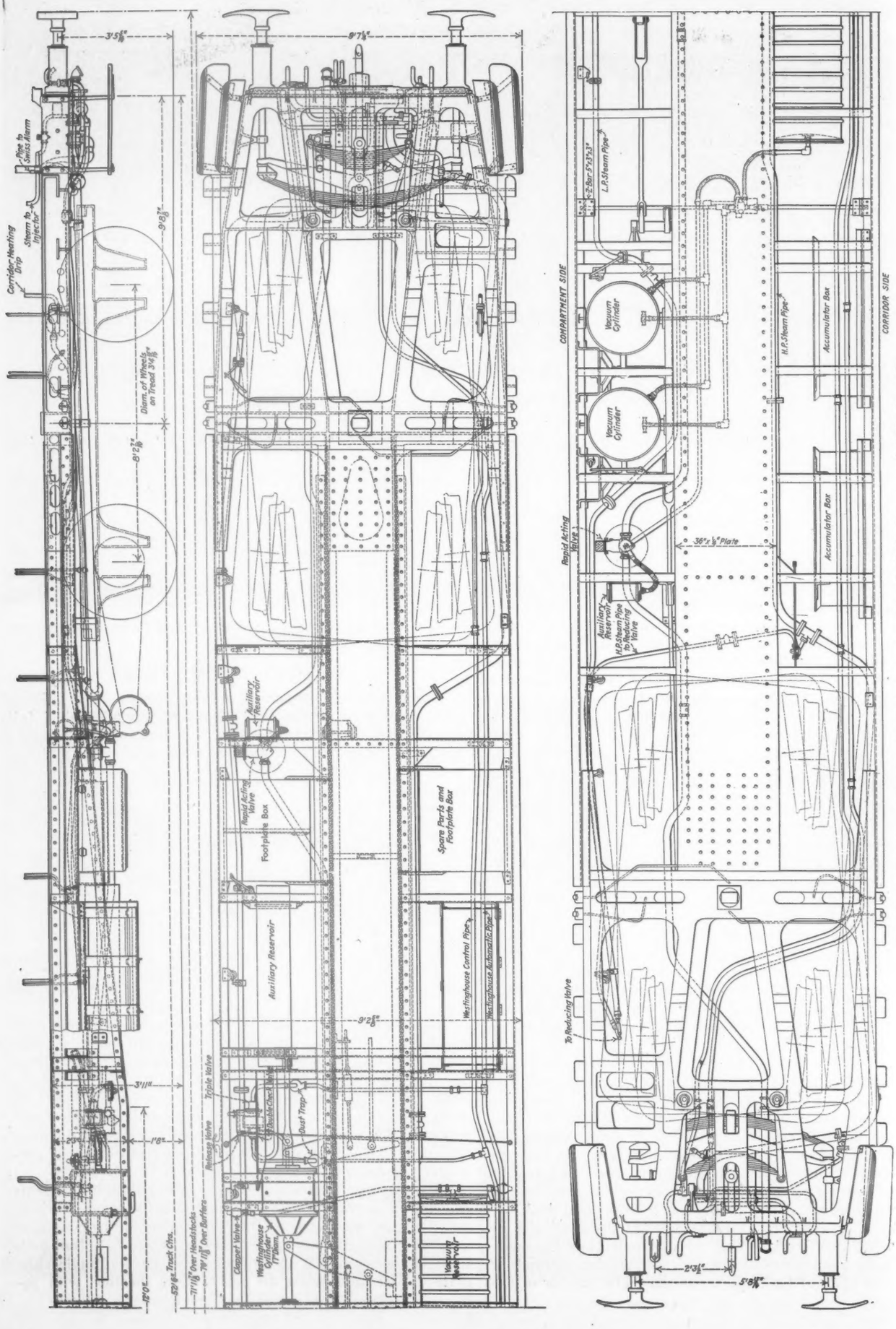
Construction of the Body

The structure of the body is entirely of steel, being built on jigs in units comprising full length compartment side, full length corridor side, body ends, platform ends, full length roof and canopies, thus insuring complete interchangeability as well as ease of production. These units, which largely consist of pressings and rolled sections, all made to templates, are readily assembled whole on the underframe, leaving the shell ready for the interior finish. To insure absence of vibration and drumming, the steel work has been covered on the inside with canvas and insulation from heat and cold has been provided. Free air circulation between the outer skin and inner finish is also arranged for the prevention of condensation.

DIMENSIONS AND WEIGHTS

Dimensions:		
Length over buffers	23.452 m.	76 ft. 11⅜ in.
Length over endsills	21.940 m.	71 ft. 11⅜ in.
Distance between truck centers	16.000 m	52 ft. 6 in.
Truck wheelbase	2,500 m	8 ft. 2⅞ in.
Diameter of wheels	1.040 m.	3 ft. 4⅛ in.
Journals	130mm by 280mm.	5⅛ in. by 11 in.
Height, rail to top of roof	4.000 m	13 ft. 1½ in.
Maximum Height	4.024 m.	13 ft. 2⅞ in.
Height, rail to center of buffers	1.050 m.	3 ft. 5⅞ in.
Maximum width	2.875 m.	9 ft. 5⅞ in.
Weights:		
In running order	54 English tons	121,000 lb.
Per axle	13½ English tons	30,250 lb.
Truck		15,230 lb.

The sides are constructed of ⅛-in. pressed steel side-posts of varying sections connected longitudinally at the base to rolled angles, which rest on the underframe, on the outside to a heavy belt-rail molding, and on the inside to a bulb section; at the top the posts are connected by two angle side-plates. The sides below the belt-rail are sheathed with ⅛-



Plan and Elevation Showing General Arrangement of Underframe and Attachments

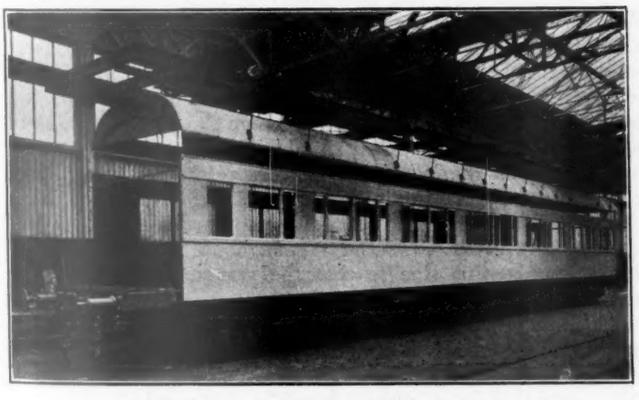
in. steel plates of a special quality. The sheathing above the belt-rail is of ⅛-in. plate, pressed in to form the window openings, four windows being pressed in one piece. Steel moldings are used to cover the butt joints of the side-plates, the whole side being riveted together with rivets counter-sunk on the outside to give a clean appearance to the exterior. The sides thus become deep girders capable of supporting the whole of the superstructure.

The roof is a departure from the former clerestory type, being elliptical. It is constructed of rolled angle carlines

Erecting Jig Is Not Removed Until Side Unit Is Mounted on Underframe

riveted to upper partition plates, the latter extending down to the side-plate level across the compartments and shaped to suit the ceiling at the corridor, the angles carrying the ceilings being riveted to either side. These upper partitions are connected longitudinally by angle upper side-plates and by angle purlins, the whole being sheathed by 1/16-in. roof plates lined with canvas to prevent drumming.

The compartment partitions of 1/16-in. steel plate with angle framing are riveted to the underframe, body side and roof and upper partitions thus effectively preventing side swaying with resultant creaking of the woodwork. To the



Lowering Roof with Crane Onto Sides

underframes and partitions is fixed a steel flooring on which is secured the wood partitions and floor covering.

The vestibule end is built up of ⅛-in. pressed steel channel section posts and cross rails, sheathed on the exterior with ⅛-in. plates and on the interior with 1/16-in. plates with steel cover moldings. Incorporated with the vestibule ends are cupboards for ice and wine, utensils and coal, with linen cupboards in the ceiling—all of steel—the cool wine cupboard being insulated with asbestos and zinc lined.

The vestibule is provided with two doorways at the sides, a door to the corridor and a communicating door to the next coach through the collapsible vestibule. These doors are of teak.

Underframes

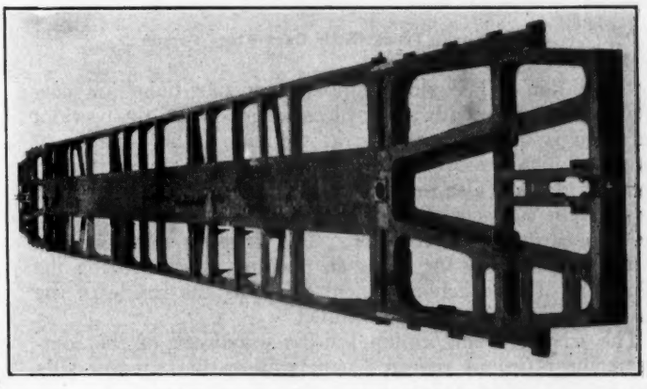
The underframes are of unusual design and consist of a small number of parts, this result being obtained by the use of large steel castings for the ends of the frames. These castings were supplied in a machined condition by the Commonwealth Steel Company, St. Louis, Mo., to the designs of the Leeds Forge Company. Although somewhat similar castings have been used for some time on heavy coaches in America, this is the first occasion on which they have been used in conjunction with side buffers. The castings dispense with a large number of individual parts which would be necessary with the type of buffing and drawgear adopted for these cars. Tail pieces extend from the end castings towards the center of the car in such a manner as to give a thoroughly strong connection with the remainder of the frame. The cast steel construction for the ends of the underframes give great resistance in the event of a collision.

The central portion of the frame consists of a fish-bellied girder built up of two web plates. The depth of this main girder at center of frame is 2 ft. 3 in. and at the part connecting to the end casting 10 in.

The four main crossbearers extend from side to side of the car passing through slots in the web plates of the center girder, other pressed crossbearers and floorbearers being built into the frame.

The side frames are made of rolled Z-sections connected firmly to the tail pieces of the end castings and arranged to form landings for the bottom angles of the body sides.

The buffing gear is of the equalizing type, the ends of the



Underframe with Cast-Steel End Pieces

buffer shanks being fitted with shoes bearing on large laminated springs and connected by equalizing bars.

Trucks

The truck frame consists of one steel casting of which the pedestals, bolster suspension brackets, brake hanger brackets, etc., are cast to form integral parts, thus reducing the number of pieces to a minimum. The wear of pin holes is taken care of by the insertion of hard steel bushings and the pedestals and bolster wearing surfaces are faced with liners. The bolsters and spring planks are also of cast steel, having been manufactured, together with the frames, by the Commonwealth Steel Company. The trucks are of the equalizing beam type with double elliptic and helical springs, designed to obtain the easiest possible riding.

Interior Finish

The floors are covered with felt, cork-lino and carpet in the compartments and with cork, linoleum and carpet in the corridors. Bronze handrails are fitted over the fixed windows in the corridor, straps and handrails are provided to enable the dropping windows to be used as a means of exit in an emergency. In the corridor are also boxes for liter-

Plan and Elevation Showing General Arrangement of Underframe and Attachments

ature, notice frames, thermometer, candle lamps and cupboards for soiled linen and spare parts.

A seat and bed for the conductor or porter is fixed at one end of the corridor. The lavatories are situated one at each end, one being provided with a water closet and tip-up wash basin, the other with a water closet only, all fittings for both being white-metal, silver-plated or polished. The ceilings are removable for access to the water tanks and piping. The lavatories are finished in white enamel, the floor composition being cement and white marble chippings.

A signal alarm apparatus is fitted, capable of being operated from each compartment and from both ends of the corridor, the alarm valve being situated in the vestibule. Each compartment has also a push-button which operates a semaphore fixed above the door in the corridor partition, the bell being at the conductor's end of the corridor. Ventilators of the torpedo extractor type are fitted to the roof, communicating to the corridor and lavatories.

The woodwork of the compartments and corridor is of polished mahogany, constructed in sections ready for fitting

Four-Wheel Truck with Cast-Steel Frame

into position. The steel compartment partitions are covered on each side with a one-piece section while the corridor partition is made up of several sections. The portions of interior finish fixed to the body sides in the compartments and corridor are also made in sections of suitable size. The wash basin cabinets are each made as one unit, as are also the cupboards in the corridor. The dressing rooms consist of two units, ready for fixing in position, thus ensuring the minimum of time actually spent finishing the inside of the car where working space is limited.

The scheme of decoration for the woodwork of the compartments is inlaid veneered panels above the window sills and figured velvet panels below, that for the corridor being embossed leather above the window sills and plain leather and lincrusta below.

The ceilings are composed of impermeable millboard to which is secured a border pattern of Anaglypta, the whole painted white and secured in position with polished mahogany moldings. The roof steel upper partitions are also covered with a frame to which is secured impermeable millboard with a border corresponding to that on the ceilings and painted white, with polished mahogany securing moldings.

The seats which have comfortable, high backs are upholstered in figured velvet, the material being supplied by the Wagons-Lits Cie., to their own design, as are also the inlaid panels and embossed leather.

The double compartments are provided with three windows of the frameless, balanced type, two dropping to the full extent, the other dropping to the extent of a top glass louvre ventilator operated from inside or out. The single compartments are provided with two windows, one dropping full, the other to the ventilator. The corridor is provided with both dropping and fixed windows. All windows are fitted with roller curtains.

The exterior of the coach sides and ends are finished in royal-blue decorated with gold lining. The roof is painted black as is also the underframe. The vestibule interiors are finished to match teak. The outside lettering on the sides is of bronze.

Heating, Water and Lighting Systems

High and low pressure steam pipes pass through the underframes, the former having connections to a reducing valve placed in the body and the latter to the individual steam heaters.

There are two heating systems, one the usual through steam heating by means of serpentine radiators in the compartments and straight piping in the corridors, the other by hot-water circulation. For the latter a heating chamber is provided at one end of the corridor, in which is fixed a coal-fired boiler. Circulating pipes of copper are run from the boiler to a hot-water tank in the roof and from thence round both sides of the car. The hot-water tank is divided into two portions, the water in one portion being heated by radiation from the water in the other portion which is heated by the boiler, the water thus warmed being used for the wash basins. The cold-water tanks fixed in the roof are also provided for supplying the wash basins. These tanks are filled from connections at the side of coach on the side sills. All tanks and piping, other than for high pressure steam, are of copper.

The electric lighting installation is of the Dick system. The current is generated by a dynamo slung from the underframe and driven by a belt from a pulley attached to one of the axles, the current passing to a pair of battery boxes slung on the frames and thence to the switchboards. Each compartment has a triple electrolier, two bulbs of 27 volts each being used for lighting, a single light with blue globe being provided as a night light. In addition there are reading lamps situated at the head of each berth. The lavatories have each one light, the corridor four lights, the vestibules one each, and one is provided in the roof over and outside each platform entrance door. The switchboard and regulator are placed at the end of corridor near the conductor's bunk.

Brakes

As these cars are run over many railway systems, some of which use the vacuum and others a compressed air brake, it has been necessary to arrange the brake rigging for use with either system. When the cars are operated in trains having the vacuum system two 24-in. diameter cylinders operate a pair of brake shafts from which the power is transmitted to the brake shoes by suitable foundation brake rigging, and when the Westinghouse compressed air system is in use, the power is obtained from a 17-in. diameter brake cylinder. Furthermore, the vacuum brake is fitted with rapid action valves while the Westinghouse brake is fitted with a double pipe line so that the system may be either automatic or controlled.

The foundation brake rigging is necessarily somewhat complicated as the brakes must be applied by either the vacuum or the compressed air cylinders, or by the hand brake controlled by a wheel placed in the vestibule at one end of the car. The trucks are equipped with a clasp brake, the shoes being suspended only 2 in. below the center of the axle. All brake-rigging is elevated well above the track.

The appearance of the end of the car is complicated by the unusual number of hose connections required for the vacuum brake, the automatic and control pipes of the air brake and the high and low-pressure steam heat hose.

Orders Have Been received in the Crewe railway works for a large number of locomotives for the London & North-Western (England). Thirty engines of a very powerful type are to be built immediately and others will follow. A large order for new boilers has also been received and the works at Crewe will be busy for a considerable time.

Freight Cars—Are They Assets or Liabilities?*

Large Opportunities for the Car Department to Decrease Maintenance Costs, Claims for Damage and Car Shortage

By C. B. Peck
Associate Editor, Railway Mechanical Engineer

THE freight car is the one factor among many that go to make up a railroad, which to the public is the ultimate measure of the capacity to furnish transportation service. No matter to what extent a shortage may be caused by a lack of other facilities, to the shipper and the public at large the situation is made known by the inability to furnish cars for loading, and is measured by the extent of the car shortage. A car shortage may be more the result of an inadequate supply of motive power, terminal facilities, passing tracks—and in some cases of main tracks—than it is of an inadequate number of freight cars. It still is true, however, that the control of the service of the car itself offers the quickest means of alleviating a shortage because it does not involve the outlay of capital for other facilities.

Utilization of Freight Cars

It is not out of place, then, to look into the various phases of freight car utilization and to see if, within the limitations imposed by other facilities, their value as assets may not be increased. Just how the average freight car spends its time depends considerably upon the demand for cars. Of course, the most effective use is made of them when the demand is greater than the supply. The latest figures available from which an answer to this question may be derived are for the month of September, 1922. Although there were a few surplus cars not in use during that period because of local maladjustments in distribution, there was a large net shortage. It is true that this shortage has materially increased since, but it was large enough in September, so that the results ought to be fairly typical of the effectiveness with which freight cars are ordinarily used.

During September the trip of the average freight car was about 438 miles, 311 miles of which were made under load and the remainder empty. This trip required a fraction over 18 days, but during this time the car spent only 1¾ days in trains. There were reported 12.5 per cent of the cars on the lines in bad order at the end of the month. This amounts to an average of 3.6 days of every trip either on repair tracks or awaiting movement to and from repair tracks, an amount more than twice the time actually spent in movement. About 2½ of the 18 days were spent in intermediate yards and terminals and almost 3 days in passing through interchanges from one road to another. Time in the hands of shippers for loading and unloading, the time required in placing, and delays over which the railroads have no control, accounted for approximately 7¼ days. This situation is summarized in the following table:

Length of average trip	438 miles
Movement under load	311 miles
Movement empty	127 miles
Time moving in trains	1.7 days
On repair tracks	3.6 days
Stored	0.3 days
In intermediate terminals	2.5 days
Passing through interchange	2.9 days
In the hands of shippers and delays beyond the control of the railroads	7.2 days
Average time per trip	18.2 days

Under the present abnormally high percentage of cars in bad order the largest single item of idle time within the control of the railroads is that caused by holding cars out of service for repairs. This situation is partly the cumulative result of the inability to keep up repairs during the war, followed by the tremendous retrenchment policy necessary during 1920 and 1921, and partly the immediate result of the recent shopmen's strike. It is true that the percentage of bad orders is now being reduced, partly by an actual gain in the number of cars repaired and partly by returning to service without repairs many cars which were set aside for general overhauling while business was slack. However, the immediate need is for the maximum constructive effort during the present heavy demand, since every car turned off the repair tracks in condition to stay off will add about $200 a month to the revenue as long as the shortage lasts.

Cycle for General Overhauling

One of the most effective means of bringing about a permanent reduction in the time spent on repair tracks, during which cars are liabilities and not assets, would be the adherence to a regular cycle of general overhauling. This is not a new idea. It was generally adopted many years ago for the maintenance of locomotives, which are scheduled for periodical classified repairs on a mileage basis in order that the maximum service may be obtained for each dollar spent in repairs with as little time out of service in the shops as possible. Conditions under which cars operate make it impossible to give them the same attention while they are in service that is given to locomotives. Isn't it, therefore, a matter of even greater importance that a regular shopping schedule be adopted and adhered to? With an established percentage of the equipment scheduled for heavy repairs regularly on the basis of from 7 to 10 or 11 years' service, depending upon the class of equipment, programs of improvement to refit the equipment to meet changing conditions could be planned and carried out before frequent failures and repeated patching have contributed materially to excessive loss of service time and excessive expenditures.

Another means of reducing the time cars are held out of service in bad order is to utilize the time each car is on a trip to the repair track by doing all work likely to require attention in the near future. The minimum time a car is held out of service is seldom less than one day, even though the work immediately required does not take more than an hour or two. When cars are as scarce as at present the loss of this day's service results in a loss of an average of more than $6.00 of revenue. Does not the saving justify taking the fullest advantage of every opportunity to make recurring trips to the repair track as infrequent as possible?

Repairing Foreign Cars

A common cause of delay on the repair tracks, in the case of foreign cars, used to be the necessity of waiting for standard material from the owner. The best data available indicates that standardization of parts requiring frequent renewal has progressed so far that there is now rarely any excuse for delays from this cause. Thus there is less reason for neglecting foreign cars than there used to be.

In the disposition of foreign bad order cars there are several business factors which are not within the control of the car department but in which it has a real interest. The first of these is the per diem rate, which, with rare exceptions,

*From a paper presented before the Car Foremen's Association of Chicago, December 11, 1922.

must be paid by the handling line even while it is holding the car out of service for repair. To the extent that this factor is taken into account in the disposition of cars it is detrimental to the foreign bad order situation. There is another factor on the other side of the account, however. About a year ago, in a paper before the Western Railway Club, N. D. Ballantine, superintendent of transportation, Union Pacific system, brought out the fact that the cost of empty mileage should be weighed carefully against the per diem cost of holding and repairing the foreign bad order car before deciding to return it empty to the owner for repairs. It is generally admitted that the average cost of moving empty cars is about five cents a car mile. Mr. Ballantine pointed out the necessity of determining whether or not the return of a bad order car to the owner would ultimately result in an equal empty car mileage in order to secure another car to replace the bad order for loading. In other words, if the prevailing movement of traffic is in the direction in which the empty car must be sent to the owner, and the distance is great, the net results to the railroad may be much more favorable if the car is retained and repaired, even at the expense of considerable per diem, and perhaps of a part of the cost of the repairs.

I have long believed that the billing prices for labor and material in the rules of interchange are on a basis too low to serve the best interests of the railroads in securing the maximum return in service for each dollar spent in repairs, as well as in reducing the loss of car days on repair tracks arising from the present generally irresponsible attitude toward the foreign car. This is a question worthy of the consideration of all men having to do either with the maintenance or the distribution and service of freight cars.

Losses at Interchange and Inspection Points

Time lost on repair tracks is not the only part of the average trip in which car department men are interested. Under the present mileage, of the average haul almost three days of each 18-day trip is spent in passing through interchanges. This is an average in which the multitude of direct interchanges between delivering and receiving lines as well as those at such gateways as Chicago, St. Louis and Kansas City are given proportionate consideration. For trips in which passing through a terminal like Chicago is included, this average is undoubtedly much too low.

Part of the time of each interchange is chargeable to the mechanical department for inspection and the set back of bad order cars after the load has been transferred. It is probably generally true that mechanical inspections are made at the same time that seal records are being taken and side cards applied by the transportation department and to the extent that this is true the mechanical department cannot be held wholly responsible for the inspection time. The responsibility for any improvement or any reduction in the amount of time required for these operations would, therefore, rest jointly with the operating and mechanical departments.

Mechanical inspection on the delivering line is not likely to be very comprehensive unless of empty cars for loading or loaded cars for unloading and reloading on its own line. Except for safety appliances and safety of running the principal responsibility for thorough inspection rests on the receiving line, because if that line fails to protect itself it is sure to be the goat in the settlement of repair bills.

But is the situation the same with respect to intermediate switching lines in terminals like Chicago? Is there not a possibility for increasing the extent to which joint inspections are depended on at the point of delivery to the intermediate line? Time is available to make a thorough inspection before the car is delivered because seal records must be taken and the car side carded. Would not a thorough joint inspection at this point satisfy the requirements of the intermediate line and permit cars to be moved for delivery without a long additional delay? The success of such an arrangement would, of course, depend on making the transportation records jointly and on side carding for ultimate destination within or through the terminal rather than merely indicating the immediate interchange.

The saving of time would not be the only advantage of such an arrangement. Would it not have a material influence in reducing the number of loads transferred by receiving lines? Certainly where the delivering line owns the cars they might frequently be repaired under load.

No doubt there are many interchange points within a terminal district such as Chicago where it would be impracticable to maintain joint inspection forces. But where all controversies over interchange are subject to the jurisdiction of a terminal inspection bureau is there not some way in which the benefits of joint inspection may be extended even beyond the limitations imposed by employing joint forces?

Reduction of Loss and Damage Claims

As has been mentioned, cars held out of service in bad order are liabilities rather than assets because, during times of heavy demand, the railroads are losing more than $6.00 per car on an average for every day so held. But all defective equipment is by no means on the repair tracks, defective cars in service are also a fruitful source of loss. Defective equipment is responsible for the payment of approximately ten per cent of all loss and damage claims and is one of the large single groups in the classified list compiled by the freight claim division of the American Railway Association. This general figure, however, does not tell the whole story, for with grain, flour and other mill products, sugar, coal and coke, 45½ per cent of all claims are attributable to defective equipment and the claims from this cause on these commodities account for 71 per cent of such claims for all commodities. Is it not evident that a proper inspection of cars for these commodities before loading at all stations large enough to employ a reasonable portion of the time of an inspector would be justified? On at least one road the payment of claims was reduced from about three cents to less than one cent on each dollar of freight revenue in a period of considerably less than one year and one of the factors in this splendid result was the development of this very practice.

Here, again, the establishment of and adherence to a regular cycle of general repairs would be of great benefit. Except for the damage caused by nails on the interior of box cars, leaky roofs and sides of box cars are probably the most common causes of claims within this classification. The condition of the superstructure when once it gets bad is not materially improved by repeated light repairs of a patchwork nature. The condition is likely to stay bad until the car is given a general overhauling. This class of claims would be materially reduced if every practicable effort were made to overhaul cars, say every eight years.

The transfer of lading is another fruitful source of loss and damage claims which rightly may be attributed to defective equipment. In a terminal like Chicago the number of these transfers runs into the hundreds—at times it might not be an exaggeration to say into thousands—every month. Every such transfer is a potential source of claims against which the railroads have a poor defense. Under the rules the receiving line, which generally makes the transfer, can usually shift the responsibility for the cost to the delivering line. I wonder, however, if the fact, that when a basis for claims is once established the payment may readily amount to more than the revenue from the consignment, is always taken into consideration when these transfers are made?

Opportunities in the Department

Many conditions touched on and the suggestions made are not entirely within the jurisdiction of car foremen or officers of the car department. However, most of the big improvements in economy of railway operation or maintenance in the future will undoubtedly come from a closer

co-operation between the various departments involved rather than through the efforts of any of these departments individually. The clearer the understanding of all factors involved by every one concerned, the more likely we are to have the kind of work required to put the whole field of railway operation in which the use and maintenance of freight cars forms so large a part on a sound business as well as on a sound technical basis.

The business aspects of this problem so far as it affects the car department are suggested by the following questions to inspectors, foremen and officers of the car departments:

To Inspectors: Are you sure that you are not asking for protection on defects which won't justify the cost of the clerical work and correspondence involved in making your protection stick? Are there not many cases where the road that pays the bill is better off than the road that avoids the responsibility?

To Foremen: Do you know that the repairs you supervise are of such a nature that the expenditure will earn an adequate return? When you have cars in for attention to such parts as draft-gears or trucks are you missing the opportunity to fix the roofs, floors, etc., so that the car will be able to earn its average of $6.00 a day without another trip on some other repair track?

To Officers: Do you try to develop sound business judgment in your supervisors with respect to the control of their expenditures? Do you encourage them to exercise their own initiative to the utmost extent? Must they follow your instructions blindly or have you given them the reasons for those instructions so that in applying them they may exercise intelligence and good judgment?

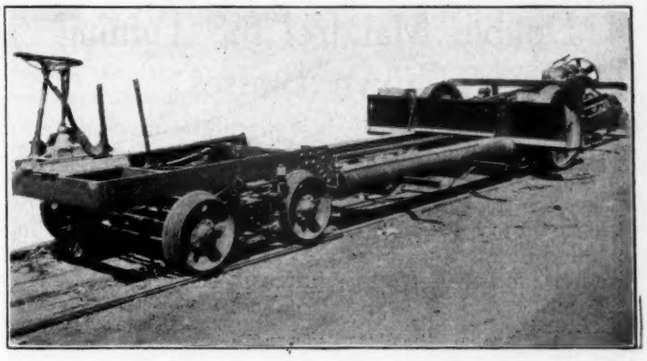
Light Weight Gasoline Car for Heavy Grade Line

THE HETCH-HETCHY RAILROAD is a 68-mile line built by the City of San Francisco to transport material for the Hetch-Hetchy water supply project. The road passes through a rugged and sparsely settled country and is built with maximum grades of four per cent. The character of the traffic is well suited for motor car operation and this type of equipment has been used for several years.

A gasoline-driven passenger car, which is of special interest because of the unique features included in the design, has recently been delivered to the Hetch-Hetchy railroad. The most striking feature of the construction is the location of the gasoline engine, which is placed at the rear of the body behind the driving wheels. The motor, rated at a nominal 25 hp., is carried on a sub-frame supported at the rear end by a long semi-elliptic spring attached to an extension of the main frame and at the forward end, near the center of the driving axle, by a pivot pin and horizontal coil springs.

This unique construction has numerous advantages. Since there are no revolving parts in front of the rear axle, a very low-hung body can be used. A considerable increase in seating capacity is also obtained without lengthening the wheel-base of the car. Vibration is minimized and motor noises, smoke, or odors are kept away from the car body.

The total length of the car is 25 ft. 2 in., while the body is 15 ft. 6 in. wide and 20 ft. 3 in. long. The driving wheels are 33 in. diameter. The four-wheel leading truck has 18 in. wheels and a wheel-base of 36 in. The distance between center of truck and driving wheels is 14 ft.

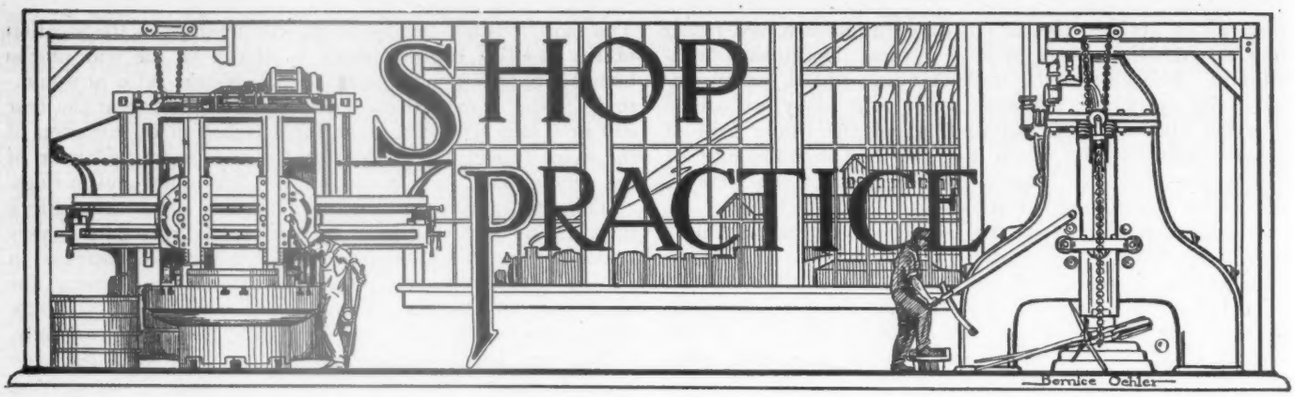


Underframe and Trucks With Motor and Controls

The brake rigging follows steam railroad practice, clasp brakes being used on the driving wheels, and single brake shoes on the forward truck. The steering wheel used on road vehicles has been replaced by a brake wheel.

The car seats 30 passengers, weighs but 10,400 lbs. complete and makes 8 miles per gallon of gasoline. It is stated that it makes the 12-mile 3.4 per cent grade on the Hetch-Hetchy at a speed of 27 miles per hour. This car is probably the lightest in proportion to its seating capacity that has yet been built, weighing only 347 lb. per passenger. It was built by A. Meister Sons Co., Sacramento, Cal.

The Location of the Engine at the Rear of the Body Is a Distinctive Feature of This Car



Double Mandrel for Turning Crown Brasses

IT is usually conceded the best practice to machine crown brass driving box fits complete at one setting on a draw-cut shaper. Where a shaper is not available, however, crown brasses are frequently turned on an engine lathe, and a special double tool-post arrangement and mandrel for speeding up this operation are illustrated in Fig. 1. Details of the mandrel and driving yoke are given in Fig. 2.

Referring to Fig. 1, it will be noted that the lathe has two tool-posts *M* and *N*, tool-post *M* having been applied after the lathe was purchased. This tool-post, being attached to the original lathe carriage, has power longitudinal feed the same as tool-post *N*. Power cross feed is not necessary in turning crown brasses and is therefore not provided.

The double mandrel consists of a 4-in. shaft, to which are applied sliding end collars *A* and *B* and center collar *C*, which is a shrink fit on the shaft. All three of these collars are forced to revolve with the shaft by hardened steel keys in suitable keyways. Three ¾-in. set screws are provided

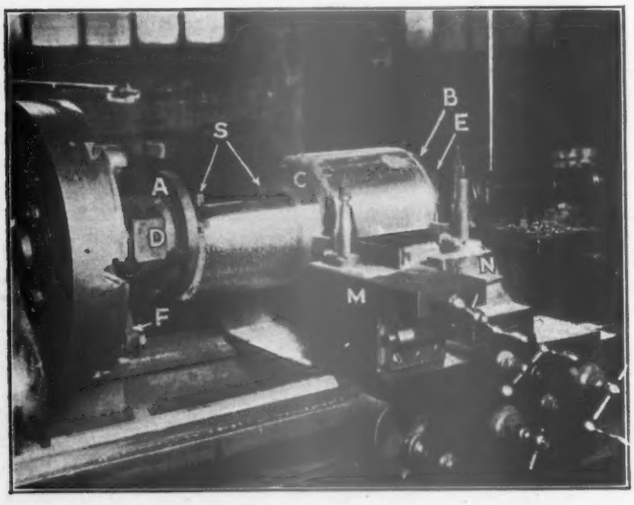


Fig. 1—Two Crown Brasses Are Turned at the Same Time

in each of the end collars and six in the center collar to hold the brasses securely in place. Set screws *S* through the 4-in. shaft provide adjustment of the brasses and assist in holding them while taking heavy cuts. The ends of the shaft are threaded to receive heavy hexagon nuts *D* and *E* and one end of the shaft beyond nut *D* is squared to fit a double driving yoke, bolted to the lathe face plate, with one end showing at *F*. Two brasses are placed in this mandrel in diametrically opposite positions and the 4-in. nuts tightened, holding the brasses against the center plate *C*. Light trial cuts are taken to see if the brasses are correctly centered and, if so, the set screws are tightened all around, holding the brasses firmly.

It is obvious that the time of turning crown brasses with this double tool-post lathe and double mandrel is little over one-half of what it would be ordinarily. It takes about 25

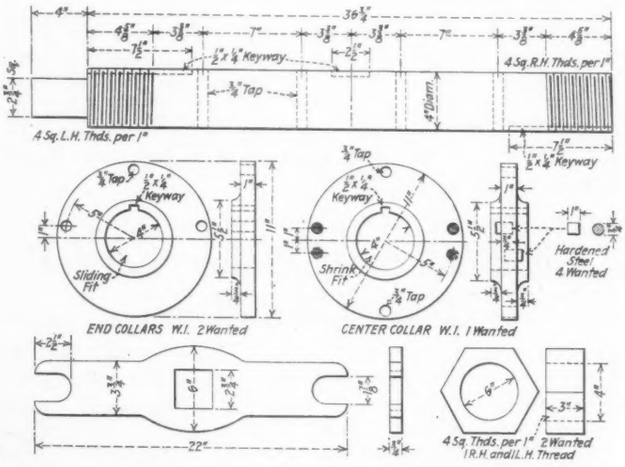


Fig. 2—Details of Double Mandrel and Driving Yoke

min. to turn a single brass, but with this double mandrel, two brasses can be turned in 28 min., or an average of 14 min. apiece, including the time of set up and taking a roughing and finishing cut. Placing the crown brasses diametrically opposite balances the mandrel and causes one tool to cut while the other tool is idle. As a result, a practically uniform torque is required to turn the mandrel; gear shock and jar are greatly reduced; and a smoother, better job is secured.

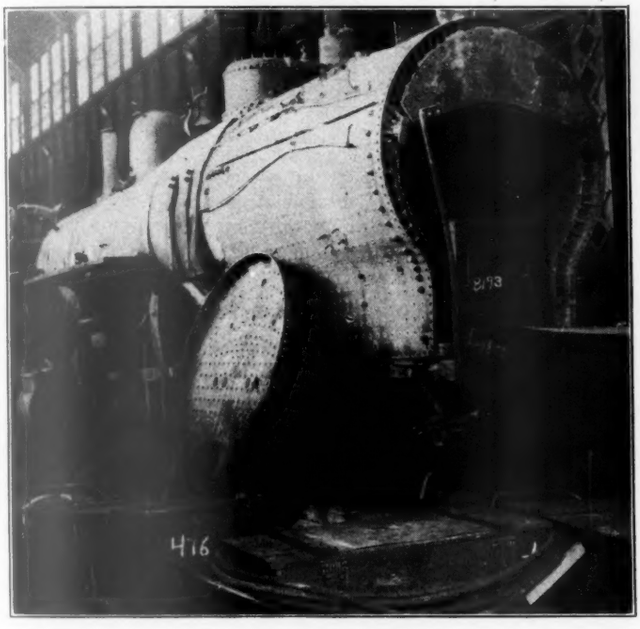
Burning Out Staybolts with Gas Cutting Torch

STRIKING results in burning out bolts of all kinds with the oxyacetylene torch are now being accomplished, and, on boiler work such as shown in the illustration, the cutting torch proves especially valuable. In the shop where the photograph was taken, one operator specializes on this work. In burning out staybolts he first melts a hole in the center of the bolt a little deeper than the thickness of the boiler sheet, then giving the hand and torch a rotary motion which completely cuts off the staybolt inside the sheet, leaving a conical end on the cut-off bolt. The shell of the old bolt left in the sheet can then be carefully removed with a hammer and chisel without damaging the

thread. In the case of rivets, experience has shown it best to burn a good-sized hole completely through the rivet, then driving out what is left of the head and shell, releasing the sheets.

Results of Tests

In an actual test the operator referred to has burned out 253 rigid staybolts in 66 minutes, or at a rate of almost four a minute. In another case where firebox side sheets were to be renewed, 1,038 flexible staybolts and 392 rivets were burned out in 15 hr. 10 min. by this one operator. Considerable skill is needed in the manipulation of the torch, in order not to burn the tip or run into the sheets or mud ring, especially when burning out long bolts or rivets. It is said that frame bolts up to 8 in. long can be burned out with a torch, the length of bolt removable in this manner depending upon its diameter. The torch is also used to cut out superheater flues, a set of 43 flues being



On Jobs Like This the Gas Cutting Torch for Burning Out Rivets and Staybolts Saves Money

cut out in 55 min. by one operator, whereas it takes about 2½ hr. with the more common machine method. Other operations economically performed include cutting out front-end netting plates, and ashpan sheets. Flue sheets can be scarfed at the rate of 12½ ft. an hour.

Method of Renewing Fireboxes

The illustration shows a method of renewing fireboxes by removing the back head, made feasible largely by the development of gas cutting of staybolts and rivets. The particular advantage of this method is that the complete firebox can be removed without taking the boiler from the frame, or drilling the outside wrapper sheet rivets and removing the complete boiler back end, as is sometimes done. This effects an important saving in time and labor.

In the case illustrated, the rivets and staybolts holding the back head, together with all other rivets and staybolts holding the firebox, were quickly and economically burned out with the gas cutting torch. A total of 1,670 rigid and flexible staybolts on this entire job were burned out by one man in 16 hours. There are 278 rivets in the back head, 270 in the mud ring and 93 rivets in the flue sheet, making a total of 641 rivets, cut out in 12 hours, also by one man. A comparison of these figures with the time required to cut out rivets and staybolts by former methods will quickly show the advantage of the gas cutting torch for this work.

Salt Baths for Heat Treating*

A NUMBER of different combinations of salts for heat treating are used and recommended by various people, but each has some vital defect or objectionable quality. Most of these combinations are eutectic mixtures of metallic chlorides, such as calcium chloride, barium chloride, sodium chloride and potassium chloride.

Calcium chloride is hygroscopic, must be carefully washed off the steel, or will cause corrosion, and has a tendency to pit. Calcium chloride alone has a melting point around 1420 deg. F., which is too high for use.

Barium chloride alone has a melting point variously stated from 1580 to 1760 deg. F., which is too high for use except for high speed steel. It is claimed that barium chloride develops a pitting action after it has been in use a few days at temperatures around 2012 deg. F. and almost immediately at temperatures around 2372 deg. F. Some authorities say, but this has not been found true by the writer, that the addition of a small amount of NaOH every few days keeps down this pitting action.

Sodium chloride melts around 1472 deg. F. and appears to be rather inert as far as corrosive and pitting action is concerned, except at the surface in contact with air. The original impurities, however, in sodium chloride such as magnesium salts, sulphates, etc., might be the source of the trouble which has occasionally been found with fused sodium chloride. The melting point of sodium chloride is too high, however, for it to be used alone.

Potassium chloride melts at around 1438 deg. F. and has the same objectionable features as sodium chloride, and in addition it has greater volatilization. Fumes of any of these salts are of course objectionable although those of calcium chloride are the most objectionable.

Sodium carbonate melts at around 1508 deg. F. and thus has too high a melting point to be used alone. There is some question as to its decarburizing effect when used at high temperatures on high carbon steel especially.

Potassium carbonate melts at around 1652 deg. F. and is open to the same objections as sodium carbonate.

Some eutectic mixture of two or more of the above salts will no doubt be the best solution of the problem.

A proper salt bath for the heat treating of complicated parts of high grade steel other than high speed steel should meet the following requirements:

1. It should have no corrosive or pitting action upon the steel.
2. It should have neither a carburizing nor decarburizing action on the steel.
3. It should melt at some temperature below 1020 deg. F.
4. It should not give off objectionable fumes at 1700 deg. F.
5. It should not attack the cast iron or alloy pot used for heating.
6. It should not deposit a sludge in the bottom of the pot.
7. It should leave only a thin film of molten salt adhering to the piece of steel as the piece is lowered into the quenching bath.
8. The salt and oil mixtures on the steel after quenching should be easily removable, by rubbing with waste.
9. The salts should be such that no harm would be done if the steel is tempered while some of the salts still remain upon it.
10. The salts should be non-hygroscopic.
11. The salts should have no rust promoting action.

* Conclusions drawn in a paper presented before the New York Chapter of the American Society for Steel Treating, by Sam Tour, metallurgist, Doehler Die-Casting Company, Brooklyn, N. Y.

Schedule Assists in Rapid Shop Reorganization

Fig. 1—Typical Department Schedule Board

Output of Jackson Shops of the Michigan Central Quickly Raised Above Normal by Simplified Shop Schedule, Efficient Trucking System and Delay Checking Department

Fig. 2—Dates for Erecting Shop Operations

WITH a normal output of approximately 18 heavy and 20 light repair locomotives a month, the Michigan Central repair shops at Jackson, Mich., closed down during the first three weeks of last July as a result of the strike, and the output dropped practically to zero. Reopening the last of the month, the shop force was being rapidly recruited when the so-called Willard-Jewell strike settlement occurred and many of the striking shop men returned, swelling the total shop force in the month of October to almost 25 per cent above normal. During August and September the shop organization was gradually rebuilt and the output increased until, in October, all departments were well balanced and functioning smoothly, so that 25 locomotives were given heavy repairs and 20 light repairs. This output represented an even greater increase over pre-strike months than the proportionate increase in men employed. It was a striking achievement considering that new men were trained, old men relocated, departments built up and the entire shop put on a production basis in three months.

TABLE I—EMPLOYEES AND OUTPUT OF JACKSON SHOPS, APRIL TO OCTOBER, 1922

	April	May	June	July	Aug.	Sept.	Oct.
Shop force	555	554	569	211	346	641	783
Roundhouse force	323	311	282	160	229	225	288
Total employees	878	865	851	371	575	866	1,071
Heavy repair locomotives	15	18	15	0	6	5	25
Light repair locomotives	23	20	19	8	20	41	20
Locos. turned in 24 hrs.	64.2	54.7	51.9	60.2	64.6	65.1	70

In view of the results obtained, a brief analysis of the shop force and output by months, as shown in Table I, will be of interest. The total number of employees at Jackson previous to the strike was about 862, of whom 556 worked in the repair shops and 306 in the roundhouse. When the strike was called on July 1, only 60 men reported for work and these men were sent to the roundhouse together with the shop foremen to keep as many locomotives as possible in service. The output of heavy repair locomotives was slow in picking up during August and September, as shown in the table, owing to the concentration of work on light repairs; but by October, the shop output had increased fully 25 per cent and the roundhouse 23 per cent.

Salient Features of Shop Organization

Credit for the rapid reorganization of Jackson shops is doubtless due first of all to the character and ability of the supervisory officers and shop foremen who remained loyal to the railroad in the emergency. They formed the foundation on which the new organization was built. Unquestionably, the factor of second importance, and the one forming the basis of this article, is the simple and effective shop schedule or routing system, by means of which shop operations are controlled. Next in importance is the efficient power-trucking system, directed by the schedule foreman, and designed to secure material and parts from the storehouse or stripping gang, keep them moving through the various shop departments, and truck them to the erecting shop for assembly as soon as they are finished. Mention should also be made of the special shop efficiency department consisting of the assistant shop supervisor and five specialists who devote practically all their time to tracing and removing the causes of delay as indicated by red marks on the schedule board. This department has developed many improved methods, jigs and fixtures which tend to speed up

W. H. Miller ——— GEN'L. FOREMAN — MICHIGAN CENTRAL SHOP ROUTING

ENGINE NUMBER	DATE IN	FRONT END STRIPPED	FLUES OUT	MACH. STRIPPED AND DEL.	PISTON VALVE BUSHING OUT	JACKET OFF	LAGGING OFF	FRAMES	CYLINDERS	CROSS TIES	DECK CASTING	FIREBOX	FLUES RESET	BOILER FITTINGS	BOILER STUDS	HYDROSTATIC TEST	STEAM PIPES	SUPERHEATER ARRANGM'T	PISTON VALVE BUSHINGS	ROCKER BOXES	ENG. BLANKED FOR TEST	UNIT TEST	VALVES IN	STEAM CHEST AND COVER	STEAM TEST AND BLOWED OUT	FRONT END NETTING	FRONT END	WHEELS	E
	1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
(A) 7758	12	12	14	13	14	15	16	23	23	23	23	18	18	18	18	18	27	25	18	24	20	27	20	X	27	29	29	20	X
(B)	12	12	14	13	14	15	16	23	23	23	23	18	18	18	18	18	25	25	18	(29)	20	25	20	X	(29)	(31)	(31)	20	X
(A) 8278	18	18	20	19	20	21	22	25	25	25	25	27	27	27	27	27	27	X	X	25	X	X	26	26	26	27	27	23	23
(B)	18	18	20	19	20	21	22	(26)	(26)	(26)	(26)	27	27	27	27	27	27	X	X	(29)	X	X	(31)	(31)	(1)	(2)	(2)	(26)	(26)
(A) 8328	23	23	26	25	25	26	27	27	27	27	27	25	25	25	25	25	25	26	X	X		27		X	27	29	29	25	X
(B)	23	23	26	(26)	25	26	27	(1)	27	27	27	25	25	25	25	25	25	26	X	X		(1)		X	(1)	(2)	(2)	(26)	X

Fig. 3—Reproduction of Upper Section of 7½-ft. by 21-ft. Master Schedule

the schedule and increase the general efficiency of the shop as a whole.

Simplified Shop Schedule System

The schedule system employed at Jackson shops is unusually simple, being carried out with as few printed forms as possible. Its success is largely due to the fact that everyone believes in it and works for it, from W. H. Flynn, superintendent of motive power; F. P. Neesley, division master mechanic, and C. W. Adams, shop superintendent, down to the youngest shop foreman.

In brief, the master schedule consists of an immense board, 7½ ft. high by 21 ft. long, taking up the entire front wall of the room in which the foremen meet frequently to discuss the progress of the work. This board is ruled in squares, and provided with a heading, as illustrated in Fig. 3. Horizontal columns *A* indicate the dates on which various operations are due, columns *B* showing the dates on which these operations are actually completed. In case of delay, these dates are marked with red chalk, indicated in the illustration by numbers enclosed in circles. Obviously, a red date is a signal for investigation and action by all concerned.

About the twenty-second of each month, the shop superintendent and foremen meet in the foremen's room to schedule engines for the following month, and another meeting is held on the tenth of the month to make necessary schedule revisions. From work reports and inspectors' reports the condition of each locomotive is known, and a reasonably accurate estimate can be made of the time needed for each repair operation. Dates are accordingly chalked on the master schedule board. All the foremen are present, and if they feel that any of the dates cannot be met, the matter is thrashed out then and there. It is the intention, however, to set the schedule slightly ahead of what can be accomplished, and continually shorten the schedule as better shop methods are developed.

The foreman of each important department has a printed form covering the work of his department to be filled out in accordance with the master schedule and carried by him for reference. This form is also duplicated in chalk on a department board, located in a conspicuous position for the information of the workmen. Fig. 1 shows such a board in the pipe shop and Fig. 4, the headings of schedule boards located in other important departments.

Dates for the completion of erecting shop work on each locomotive are chalked on an 8-in. by 9-in. piece of sheet

DRIVING BOX GANG

ENGINE NO.	Shoes & Wedges		Valve Bushings		Driving Boxes							
	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK

MOTION WORK GANG

ENGINE NO.	Rocker Box		Reverse Shaft		Motion Work		Throttle L		Reverse L		Power R	
	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK

SPRING RIGGING BRAKE RIGGING

ENGINE NO.	Spring R		Brake R		Trailer T		Engine T					
	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK

PISTON GANG

ENGINE NO.	Pistons		X-Heads		Piston Valves		Valve X-Head		Intercepting Valve		Stoker	
	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK

WHEELS

ENGINE NO.	Driving Wheels		Trailer Wheels		Engine T Wheels							
	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK

ROD GANG

ENGINE NO.	Main Rods		Side Rods		Dome Caps		Ecc. Cranks		Ecc. Rods		Guides	
	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK	Rec.	OK

Fig. 4—Headings of Important Department Schedule Boards, Similar in Size and Lay-Out to the Board Shown in Fig. 1

SCHEDULE JACKSON SHOPS MONTH OF September 1922

29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
CENTRICS	DRIVING BOXES	SHOES AND WEDGES	TRAILER TRUCK	ENGINE TRUCK	PIPES UNDER JACKET	BOILER LAGGED	JACKET	SPRING RIGGING	REVERSE SHAFT AND BOXES	REVERSE LEVER AND REACH ROD	MOTION WORK	GUIDES	CROSSHEADS	PISTONS IN	RUNNING BOARDS AND CAB	REWHEELED	AIR BRAKE EQUIPMENTS	SIDE RODS	MAIN RODS	BRAKE RIGGING	GRATES	ASHPAN	ASHPAN OPERATING DEVICE	PILOT	VALVES SET	HEADLIGHT	PIPE WORK	TENDER	ENGINE OUT	CLASS OF REPAIRS		
20	20	X	23	18	23	24	22	25	25	25	25	25	29	25	23	31	28	25	26	2	31	31	26	26	2	2	2	2	2	7758		
20	20	X	(29)	18	23	24	22	(31)	(31)	(31)	25	25	(2)	25	(29)	(2)	(26)	(26)	(31)	2	31	31	26	(2)	2	(7)	2	(7)				
23	24	X	25	27	27	28	25	25	25	25	25	25	25	27	25	3	31	27	29	5	2	2	2	29	5	5	5	5	3	8278		
23	24	X	(31)	27	27	28	(26)	25	(31)	(29)	(27)	25	(31)	27	(27)	(5)	(2)	(29)	(2)	(7)	(7)	(7)	(7)	(2)	5	(7)	5	(9)				
25	25	27	27	25	28	29	27	27	27	27	27	27	29	29	27	5	2	29	2	8	5	5	5	2	7	7	7	7	3	8328		
(26)	(26)	(1)	(1)	25	(1)	(2)	(29)	27	(31)	27	(31)	(29)	(6)	29	(31)	(6)	(7)	(31)	5	(9)	(9)	(9)	(9)	(6)	7	(12)	7	(12)				

Board, Taking Up the Entire Front Wall of the Foremen's Room at Jackson Shops

iron, painted, lettered and attached to the cylinder, as shown in Fig. 2. Dates when material should be received from the machine shop and when it should be applied to the locomotive are shown. Erecting shop men are thus enabled to tell exactly when different operations are due without consulting the foreman. The only other forms in connection with this simplified schedule system are two small ones used to report delays to the foremen, and causes of delay to the shop superintendent. There are, however, two additional small shop forms, one being a work order slip form for outside work and small material not mentioned on the schedule, and the other consisting essentially of a form issued by the schedule foreman for the movement of material.

Work Order Slips Effectively Used

The work order slip (Fig. 5) is of sufficient importance to be described in some detail. In general, it is made out in triplicate by a foreman who needs work done in another department. The original white slip goes to the department which will do the work; the second blue slip goes to the routing office which looks up pattern numbers and gets the rough material from the storehouse or casting platform; the third yellow slip is retained by the issuing foreman for reference. When the work is completed, the time is entered on the original slip; it is signed by the foreman and returned to the routing office which arranges for the finished material to be trucked to the proper department. The work order slip also serves as a record of time spent on individual jobs and is used in computing costs.

A typical work order slip, made out for 20 hexagon head frame bolts, is illustrated in Fig. 5. It is issued by an erecting shop foreman against the blacksmith department which, if the bolts are not in stock, makes them on a forging machine. As soon as the bolts have been forged, the blacksmith foreman fills in the time on the work order slip and returns it to the schedule office. The schedule, or routing foreman, then knows that the bolts are made and fills in form 234 (Fig. 6), giving it to one of the truckers, who

FORM MC-MP169 Adopted 4-19 500 blks 4-22-E-1720

THE MICHIGAN CENTRAL RAILROAD CO. No 8851

WORK ORDER SLIP

TIME WORK SLIP RECEIVED

LOCO. No. 8076 SHOP Blksmith DATE 10-9-1922

QUANTITY	DESCRIPTION OF WORK
20	1" x 6" Hex. Head Frame Bolts

When Wanted 10-11-22

DATE AND TIME JOB FINISHED 10-11 9 A. M. ~~P. M.~~

John Doe
Foreman

A. R. Smith
Foreman

Fig. 5—Typical Work Order Slip Made Out Against the Blacksmith Department

trucks the bolts to the machine department for turning, and subsequently to the erecting shop foreman who issued the original order.

Special attention is called to the work order board (Fig. 7) attached to the forging machine water pipe, as illustrated. One half of the board is painted black and marked "Work Order," the other half being painted red and marked "O.K." Two hooks are provided at the bottom, and when a work order slip is received at the forging machine, it is hung on the black hook at the left. When the work is completed, the slip is transferred to the red "O.K." hook at the right. Most people hate to see a lot of work piled up ahead of them waiting to be done and advantage is taken of this trait of human nature by means of the work order board. It is used not only at the forging machine, illustrated, but at every important machine and job throughout the shop. Workmen naturally try to get the slips onto the O.K. hook as fast as possible. Moreover, foremen can walk through their departments and tell at a glance which machines have a lot of work ahead and which will soon be caught up.

Dates on the master and department schedule boards are made with yellow chalk, the date when the work is actually completed being put on with blue chalk, except in the case of delays, when red is used. Delays are, therefore, indicated on the master department schedule boards by red dates which

FBM-234

THE MICHIGAN CENTRAL RAILROAD CO.

MR A. R. Smith
FOREMAN

WORK ORDER SLIP NO 8851 LOCO NO 8076

FOR 20 - 1"x6" Hex. Head Frame Bolts

HAS BEEN COMPLETED TODAY 10-11 19 22 AT 9 AM ~~OR PM~~
DATE

RECEIVED 10 19 22 AT 10 AM ~~OR PM~~

J. Ryder
ROUTE FOREMAN

Fig. 6—Brief Form Indicating That Work Is Done (Essentially An Order for the Movement of Material)

are conspicuous and attract attention. In order to avoid questioning and possible censure, there is a definite effort on the part of both foremen and men to have as few red dates as possible appear on the boards.

In addition to the monthly schedule meeting, the foremen meet every Monday, Wednesday and Friday after working hours to check up the progress of the work, settle any questions which may arise, and discuss any suggestions for improved shop operation. Minutes of these meetings are taken in shorthand and later distributed to the various foremen who thus have a permanent reminder of the points discussed. These meetings prove extremely effective in ironing out any differences which may arise between the respective foremen, enabling them to work as a unit for the general betterment of the shops.

Schedule Foreman Has Charge of Routing System, Trucking and Shipping to Outside Points

Shop schedules can never be a success unless run by men of extensive practical shop experience. Obviously, if a clerk is employed simply to go through the motions of filling out forms in the office, the results will be negligible as far as increasing shop output is concerned. As previously intimated, the importance of the schedule is appreciated at Jackson and a real job has been created for the schedule foreman who has general charge of the routing system, work order slips, trucking material, and shipping to outside points. This schedule foreman is relieved of minor details by an assistant who checks the progress of the work each morning and afternoon. A clerk is also provided in the routing office to take care of all work order slips and shop orders.

The importance of the prompt movement of material and its relation to the shop schedule is recognized by giving the schedule foreman three Ford gasoline tractors and three Mercury storage battery tractors together with 10 laborers for operating the trucks and handling material. The schedule foreman, knowing when the work on various locomotive

parts is completed, is in the best position to see that this material is moved promptly. As fast as one operation is completed on a part it is moved along to the next machine.

The schedule foreman also has direct charge of ordering and shipping all material to outside points, which work bulks large in the Jackson shop operations. While the erecting shop is of the longitudinal type and more or less difficulty is experienced in transporting material through it on that account, an effective trailer and tractor system has been developed which not only speeds the movement of material through the shops but saves a great amount of hard manual labor, formerly required when trucking by hand. The trailer system has another advantage in that material can be loaded on the trailers and then moved, a considerable number of

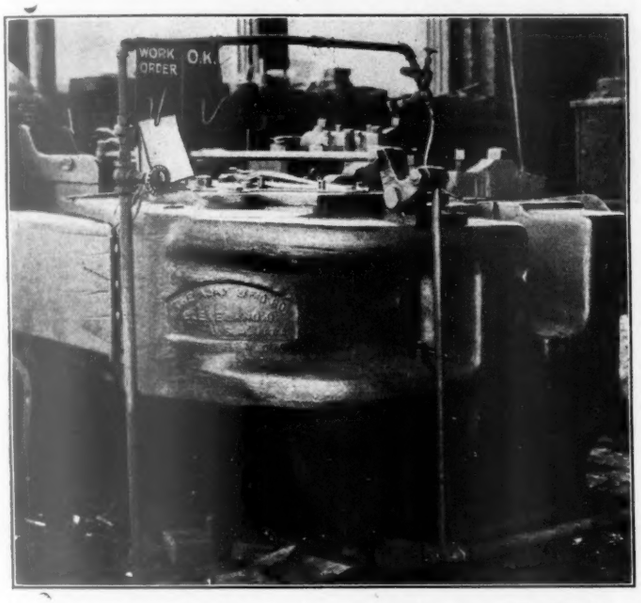


Fig. 7—Men Like to Get Work Order Slips on the "O. K." Hook

units at a time, without tying up a tractor or being compelled to wait for one.

The importance of the schedule foreman in the scheme of shop operation described is evident and it seems logical that the man who has charge of the progress of both schedule and outside work should also have charge of getting the material, moving it from point to point about the shop and shipping it to outside points when completed.

Unusually Heavy Repair Work at Jackson

A close examination of the master schedule, illustrated in Fig. 3, will show that the first three locomotives were allowed 18, 16 and 14 days in the shop, the time actually taken being 23, 18 and 17 days respectively. While these shopping periods may appear unduly long, it should be noted that in each case the locomotive was given unusually heavy repairs involving jacket and lagging removal and firebox repairs. Probably there are shops no larger than those at Jackson, which turn out more than 25 heavy repairs a month, but in fairness it should be pointed out that locomotives sent to Jackson shops are given unusually heavy repairs and in fact many locomotives, credited only with light repairs, receive practically heavy classified repairs owing to the rigid Michigan Central ruling on mileage. (Unless a locomotive has made a specified mileage, it cannot be given general repairs.) The proximity to the roundhouse and consequent large number of light repair locomotives also tends to disrupt the shop organization for heavy repair schedule work. In fact, preference is given to light repair or roundhouse work whenever it conflicts with the schedule work.

Shop Efficiency Department

Railroad shops, unfortunately, are not like the "one horse shay," with each department as strong as the other. In consequence a close observation of the master schedule board will usually show weaknesses in certain departments. Obviously, it is the duty of the shop superintendent to take the necessary steps to strengthen weak departments, but one man cannot attend to all the details of this work which is handled at Jackson shops by a special efficiency gang, under the direction of the assistant shop supervisor. The gang consists of two machinists, two boilermakers and one blacksmith, all expert workmen experienced in their respective lines.

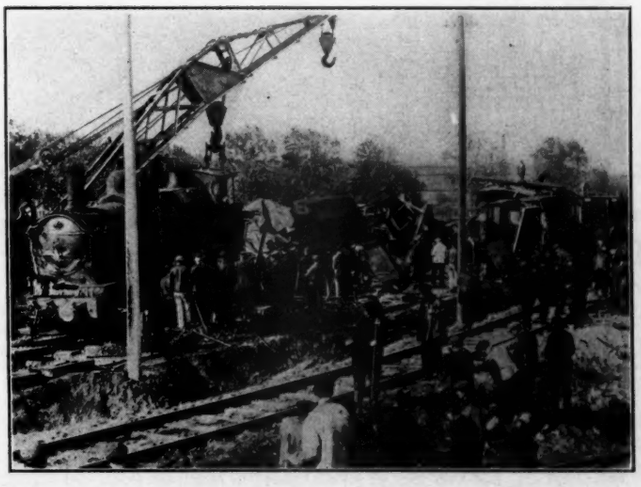
A series of red marks in the same department, as shown on the schedule board, always indicates some trouble which may be caused by inefficient machines or methods. In either case some slight change will often remedy matters and allow this department to get its work done on time and eliminate the red marks. As a rule, when one department has been brought up to the mark in this way, some other department proves to be the limiting factor and so it goes. As a result of the work of the efficiency department, a continual improvement in shop methods and output is obtained.

Among the devices which have been developed comparatively recently may be mentioned a double crown brass turning jig, a power-operated device for pulling in cylinder bushings, a jig for milling throttle lever quadrants, a motion work bushing press, several effective brass room tools, a set of guide liner dies, etc.

Experimental Room

Another unusual feature at Jackson shops is an experimental room in which is segregated all the tool work done for the efficiency department. This experimental room is entirely separate from the main toolroom, being equipped with an 18-in. lathe, an upright drill, a 24-in. shaper and a grinder. All new jigs and fixtures, or devices intended to facilitate the shop work are made in this experimental room, which is allowed to be used for nothing else. It is well known that where work of this kind is carried on in the ordinary toolroom it becomes sidetracked whenever a rush job comes in, and the result is a delay in the development of new tools if the work is not stopped altogether.

In view of the results accomplished, it may safely be said that the shop schedule, as installed at Jackson shops, has justified its existence. It amply fulfils the expectations of those who for years have advocated this method of controlling railroad repair shop operations.



International

Derailment Near Paris, France

Powerful Valve-Setting Rolls

THE work of setting valves on modern heavy locomotives can be greatly facilitated or retarded, depending upon the method employed for rolling the main wheels. Many types of hand-, pneumatic- and electric power-driven rolls are used, but in the majority of cases these are not entirely satisfactory. They frequently lack sufficient power, provide too jerky motion, or are difficult to set up. To overcome these difficulties a new electric power-driven unit, arranged to drive the rolls through a powerful universal joint, has been developed at the Jackson shops of the Michigan Central, as illustrated in Fig. 1. A plan and elevation of this device, together with construction details are shown in Fig. 2.

The principal advantage of this device is that sufficient power can be instantly obtained by means of the convenient controller handle, to revolve the main wheels in either direction one complete revolution in 30 seconds. Moreover, the controller handle provides easy and accurate control of the motor, enabling fine adjustments of driving wheel position to be obtained. It is said that adjustments less than 1/64 in. of the driving wheel circumference can be obtained, thus saving a large amount of time formerly spent reversing the wheels whenever they went beyond the mark. Other advantages are the ease of set-up and the fact that the compact power unit is mounted on a truck, readily movable about the shop. One man can easily apply the rolls beneath the wheels, move the truck into position, connect the universal coupling and be ready to turn the wheels inside of 15 min., depending somewhat on how far it has been necessary to go for the truck.

Referring to Fig. 2, it will be noted that power is supplied from a 5-hp. motor, operating at 810 r. p. m. and transmitting power through suitable reduction gears, a 1-in. single lead worm with 31 tooth gear, to the universal joint and rollshaft. All gearing is carefuly protected and the controller box so located that the handle is within easy reach of the valve setter. The truck wheels are made small and the entire power unit built as low as possible so that the drive shaft on the truck will be only slightly higher than the rollshaft. The universal joint, therefore, operates efficiently at a very slight angle. The truck could be handled more

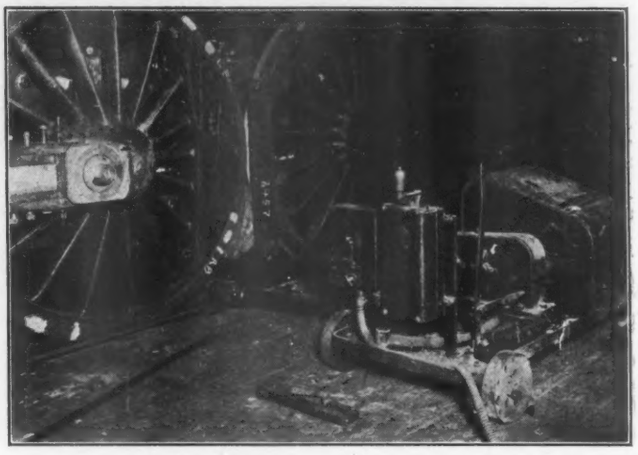


Fig. 1—Compact and Readily Portable Unit for Rolling Main Wheels in Valve Setting

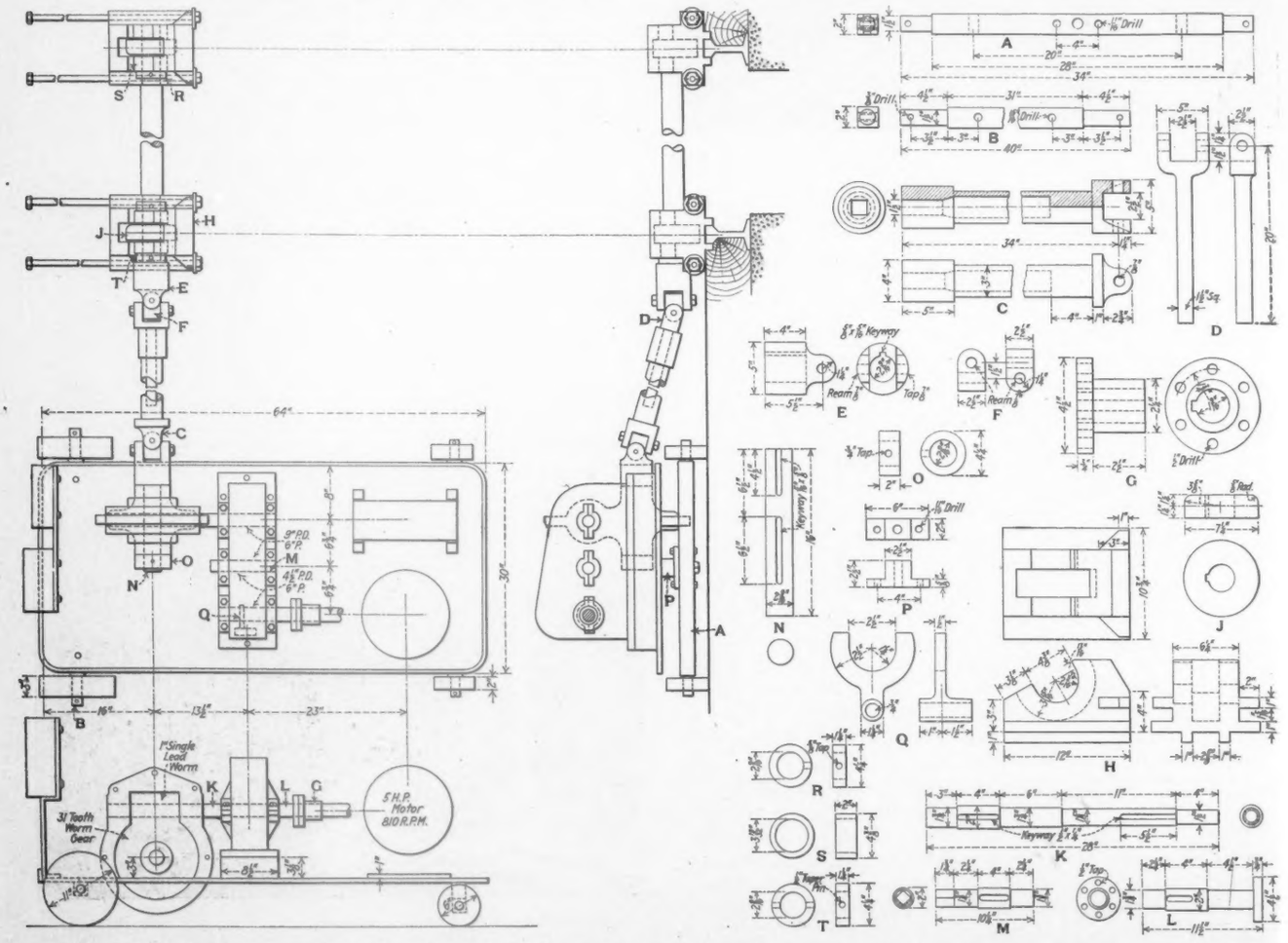


Fig. 2—Plan, Elevation and Details of Powerful Valve-Setting Rolls Developed at the Michigan Central Shops, Jackson, Mich.

easily about the shop with larger wheels, but experience showed that it was necessary to have the entire power unit as low as possible.

The rugged design of the universal joint is evident from the illustration. Another point worthy of attention is the comparatively large rolls in contact with the driving wheels. These rolls are 7¼ in. in diameter and provide a larger arc of contact with the driving wheel tire than would be obtained with smaller rolls. It is stated that these rolls will turn the driving wheels without removing any of the weight on the driving boxes. The entire arrangement of power unit and rolls is the result of considerable experiment at Jackson, and the final design as illustrated seems to be entirely satisfactory.

Principles of Oxyacetylene Fusion Welding

Part 9—Welding Low Carbon Steel

By Alfred S. Kinsey*

LOW carbon steel is the easiest of all metals to weld except wrought iron, which is due to the fact that it is almost free of chemical impurities such as carbon, silicon, manganese, phosphorus and sulphur. The nearer the steel approaches pure iron the easier and better it can be welded. That is, it is less liable to be oxidized with a small percentage of chemical ingredients.

Worn Couplers Reclaimed by Oxyacetylene Welding

Step 1.—Use a flash joint for very thin steel. In the welding of thin steel the edges should be bent up about 1/16 in., thus forming what tinsmiths call a flash joint. The edges then should be laid closely together, making a butt joint, and their upright edges melted down flat. This takes the place of welding rod and prevents the weld from being thinner than the rest of the metal. No flux is needed. The thinnest sheet steel may be welded this way with the oxyacetylene torch.

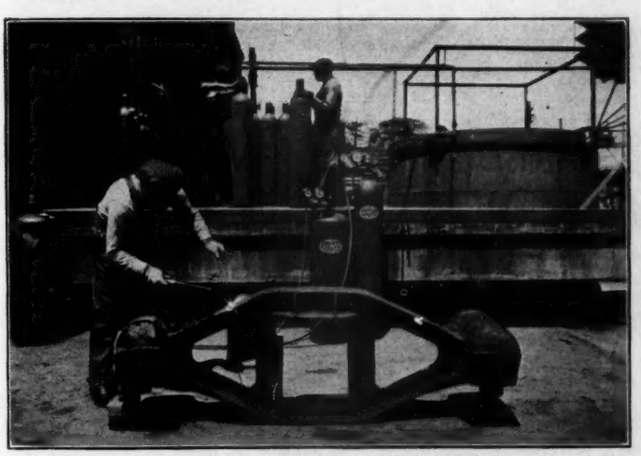
Step 2.—Use a butt joint for sheet steel. For 1/16-in. to ¼-in. sheet steel, all that is necessary is to place the edges together and weld them. No flash or rod is necessary, unless there should be a liberal collapse of the metal at the weld. Then a ⅛-in. pure iron rod should be melted down into the joint.

Step 3.—Use a single vee joint for light steel plate. For steel from about ¼ in. to ¾ in. thick the edges to be welded should be beveled at an angle of 45 deg. each, or a total of about 90 deg. between the edges to be welded. The bevel should end with a sharp edge at the botton. The vee formed by the two bevels is necessary in order that the metal may be melted from the bottom upward. If no vee was used the flame could not penetrate through the metal to the bottom without burning the surface metal which was melted first.

Do not place the edges closely together. Separate them from 1/16 in. to ⅛ in. so that the flames may lick the metal under the joint, and also so that any slag may flow down through and out of the joint. The strongest welds of this type are made by leaving the joint open and then tacking a butt plate under the joint about ⅛ in. away from the metal. This allows the slag and some of the clean metal to flow through the joint, and thus insure that the whole vee is filled with clean, strong metal. Of course the butt plate is removed after the weld is cold.

Step 4.—Steel should be double-veed for thick welds. Steel over an inch thick should have its ends veed from the top surface down to the middle and from the bottom surface up to the middle of the metal. This will make double vee, both of which can be filled with welding rod. On steel of ordinary thicknesses this may be quickly accomplished, but in the heavier sections, like the frame of a locomotive, for example, which might be 5 in. thick by 7 in. high, the welding should be done as fast as possible, and in order to do so both vees should be welded at the same time. That is, two welders should work at the job at a time, one in each vee, and it has been found that the most satisfactory way is to use three welders on that size job, one of the two welders being relieved about every 15 minutes by the third man.

Step 5.—Steel should be heated slowly to a red heat. In welding steel it might be assumed that because the oxyacetylene flame has a temperature of about 6,300 deg. F., it should be used to heat up the ends to be welded as fast as possible. This would not be good metallurgy. No matter what is to be done to the steel, if it is heated to a bright red



Welding Tension Member of Truck Side Frame

*Professor of shop practice, Stevens Institute of Technology; advisory service engineer, Air Reduction Company.

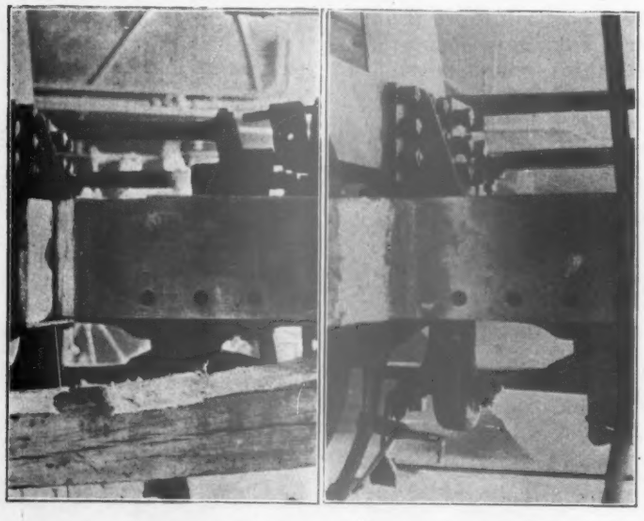
the heating should be done slowly until the metal has reached a bright red color, which corresponds to a temperature of about 1,200 to 1,400 deg. F., when the heating may proceed as rapidly as desired. The reason for this is that the flat-sided grains of steel are composed of crystals which are interlocked when the metal is cold, and which must be separated by expansion as the metal is heated. Slow heating allows the crystals to unlock without deforming them, and once they are separated rapid heating can do no harm. Then when the metal cools down the grains will fit flat side to flat side and the untorn crystals will reassemble as originally arranged, and the shrinkage of the metal will take place without the development of any of the shrinkage cracks sometimes found in a weld.

Step 6.—Steel welds should be thoroughly fused. Before attempting to melt the welding rod into the vee of a weld, the welder should be sure that the metal of the ends to be welded, called the base metal, is flowing. By that time the welding rod should have been slowly heated to the melting point. Then the two molten masses will run together and fuse satisfactorily. That is, when the whole molten mass is of uniform temperature, there will be an equal opportunity for all of the grains of the metal to come in contact with one another, they will fit snugly and there will be no unequal rates of cooling to form shrinkage cracks.

In welding thick steel it is common practice for the welder to use two ¼-in. rods side by side rather than one thicker one which would be harder to melt.

Step 7.—Steel welds should be hammer refined. It should be remembered that when a steel forging or a piece of rolled steel bar is welded by fusion the metal is melted in the vee and then allowed to become cold and solid. The metal therefore has been changed from a fine-grained forging to a coarse-grained casting, and thereby it has lost from 10 to 25 per cent of its tensile strength. This can be mostly overcome by hammering the weld after the metal has cooled from the liquid condition to a bright red color.

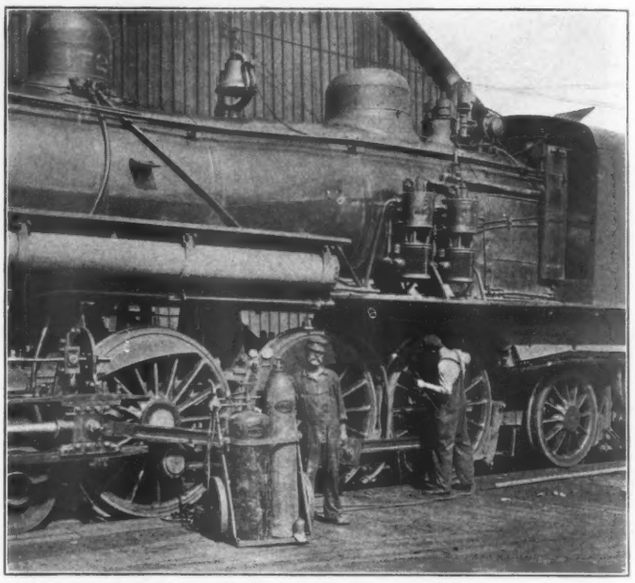
The reason why the steel in the cast condition is weaker than when it is in the hammered or rolled state, is that when it is allowed to cool from the liquid condition to the solid



Broken Locomotive Frame Before and After Welding

the grains do not shrink to their former size, nor do they go back so closely together. The grains of steel are flat-sided, and the strength of the metal depends largely on these sides being brought in close contact so that the law of attraction which holds them together will not be interfered with. In addition to this, each grain is composed of crystals which arrange themselves somewhat like a fern leaf, each group fitting into the next one so that they are uniformly distributed and closely in touch. Now when heat is applied to a piece of steel its crystals gradually unlock and separate, which causes the grains to enlarge and pull away from the adjoining grains, thus enlarging the whole piece of metal. This is called the expansion of steel, and amounts usually to about 3/16 in. per foot of length.

If the steel is heated to the liquid state, the attractive power between the grains will be almost all gone and the air may get into the metal and form a thin scale of oxide between the grains. Then when the metal cools to the solid condition the attractive power is reduced because of the poor



Building Up Sharp Driving Wheel Flange

contact of the grains, and in addition to this the crystals do not go all the way back to their original position of interlocking. The whole piece of steel therefore is weakened.

Now if after a weld of steel is made the metal is allowed to cool to a bright red and is then hammered well with a regular blacksmith or machinist hammer, the oxides will be forced from between the grains, the grains will lie in closer contact, and the jar from the hammer blows will cause the crystals to go back almost to their original position, thus making the grains smaller. This is called *hammer refining* steel, and it similates the condition under which the steel forging or rolled bar steel was made before it was welded. It is well known that the finer the grains of steel the stronger will be the metal. For example, if a piece of soft tool steel is heated to a bright red and then immersed quickly in cold water its grains will be refined to about half their former size, and the tensile strength of the steel will have increased about 25 per cent. But of course as the low carbon steel weld cannot be heat treated this way, its grains must be hammer refined. It is to be remembered that only a few metals will stand hammer refining. Cast iron will not take any hammering at all.

Step 8.—Steel welds should be reheated. After the completion of a good size weld of steel it should be reheated to a dark red color, about 1,000 deg. F., until thoroughly heat-soaked, then covered with sheet asbestos to insulate it from the air, and allowed to cool slowly. This will bring all of the grains of the steel to an equal temperature and thereby relieve any unequal strains between the grains which might have been caused by the weld cooling at unequal rates. Once the piece of steel is uniformly heated and the strains equalized the good results can be retained only by unheating the whole job at a slow, constant rate. In ordinary work this can be satisfactorily accomplished by covering with asbestos. It is true that but very little of this reheating has been prac-

ticed so far, but it is also true that some welds have developed cracks when cold which the welder could not explain. The reheating of a big steel weld may be economically done by the use of a big burner using kerosene or fuel oil or some cheap gas.

Step 9.—Steel welds should be annealed. This may be accomplished by heating the whole job to a bright red color, about 1,400 deg. F., and allowing it to unheat very slowly while in a charcoal pack. It will be noticed that this is an operation for the annealing or softening of the weld which is quite different from relieving unequal granular strains. To anneal a piece of steel means to change the nature of its carbon. When a weld is being made and the metal is changed from the solid to the liquid state all of the carbon in the steel takes the form of cementite carbon. Then if the liquid metal is allowed to change back slowly to the solid condition the cementite carbon transforms to its usual nature in solid soft steel of pearlite carbon. But if, as often happens, parts of the weld are allowed to cool quickly and irregularly, only part of the hard cementite carbon goes back to pearlite carbon, and the metal will be hard and soft in spots. The hard spots may be filable, but they are nevertheless too hard to harmonize with the soft metal, and the whole job should be uniformly annealed. Therefore the metal must be heated past what is known as the recalescent point (about 1,400 deg. F.), which is the point of retransformation of the cementite carbon to pearlite carbon, and then unheated very slowly by being packed in crushed hardwood charcoal.

Notice that the color and temperature for annealing are a bright red and about 1,400 deg. F., while those for relieving granular strains are a dark red and about 1,000 deg. F. These temperatures are not hard to approximate. The annealing temperature of 1,400 deg. F. may be exactly determined by testing the metal with a small horse-shoe magnet. When the recalescent point is reached steel is non-magnetic and it will not attract a magnet.

Step 10.—Steel welding rod. When a piece of steel is veed preparatory for welding care should be taken to see that the vee is filled with metal of the same nature and physical characteristics as the original bar, called the base metal. For example, if the steel has a tensile strength of 50,000 lb. per square inch the weld metal should have about the same strength and this would be determined largely by the character of the rod fed into the weld.

It is well known that if a welding rod is of exactly the same chemical composition as the base metal the resulting weld will be weaker than the base metal. For example, it has been attempted to weld worn locomotive driving-wheel tire flanges with turnings from the same kind of tires, but the welds were so inferior that they failed. It is also a well known fact that to use a piece of steel sheared from a piece of boiler plate, to weld that same boiler plate, will make a weld weaker than the base metal.

It is recognized therefore that welding rod must be made with its chemical elements so selected and proportioned that the completed weld will be as strong as the original bar.

Now even though welding rod is made of proper chemical and physical characteristics to produce good welds, such precautions may be made valueless by improper handling of the rod by the welder. When a weld is being made the bottom and sides of the vee first should be thoroughly melted and a pool formed, and then the rod melted down into the molten mass. This will make good fusion and a satisfactory weld. Care should be taken not to let the rod melt and run down on the metal of the vee before the vee is melted and flowing at the bottom.

Again the best results may be obtained by using the welding rod a little as a puddle-rod to stir up the molten metal sufficiently to allow the oxides to float to the surface and be taken out of the weld.

In big steel welds it is better to use two ¼-in. rods held side by side and melted at the same time, than to use one bigger rod. The melting of the smaller rods will be more easily controlled.

It will therefore be seen that so far as welding rods are concerned they should be carefully selected for chemical and physical properties, and that they then must be fused properly into the vee.

Safety First for Crane Repairmen

THE illustration shows a safety device designed to prevent accidents to shop employees while repairing cranes. The switch, shown at the right in the illustration, is in the main circuit to the electric traveling shop cranes. In case of a crane breakdown, the man who is to make inspection or repairs goes to the powerhouse, opens this switch and locks it in the open position by means of the padlock, shown, and a key given to him by the power plant engineer. He retains this key while necessary crane repairs are being made, and it is impossible for anyone to close the

Lock for Crane Switch in Power House

switch, accidentally or otherwise, and possibly kill whoever is on the crane at the time.

After the crane repairs have been completed the man in charge of the work returns to the powerhouse and unlocks the switch with his own hands, the engineer then throwing in the switch. This relieves the power plant engineer of responsibility and insures that no workmen are on the crane when power is turned on. While the crane switch lock may seem an unnecessary precaution, the fact of the matter is that accidents of the kind mentioned have actually occurred. The bracket and lock arrangement, illustrated, affords a positive means of preventing such accidents.

Problems in Hardening Steel

ONE of the most fascinating and yet obscure subjects in ferrous metallurgy concerns the problem of hardening steel by a suitable quenching treatment and subsequently tempering it by slight heating. The interest is centered around the hard constituent or structural condition, known as martensite, the name being derived from the noted German metallurgist, Martens. An investigation, recently completed by the Bureau of Standards, Washington, D. C., has a bearing on this general subject, and the results are published in scientific paper No. 452, entitled "Structure of

Martensitic Carbon Steel and Changes in Microstructure Which Occur Upon Tempering."

The study with which this paper deals was based upon the microstructure of a series of steels of progressively increasing carbon content, when hardened under different conditions of temperature and heating periods, and the changes in structure which ensue in them upon careful tempering.

Practically nothing is gained in hardness by using very high temperatures or very long heating periods prior to the quenching of steel, provided that the "critical" temperature is exceeded upon heating. This conclusion was based upon small specimens treated in the laboratory; in practice, of course, allowance must be made for the size and shape of the pieces treated. The general conclusion is valid, however.

The changes which take place in a hardened steel upon tempering occur in well-defined stages. Until the temperature of reheating exceeds 250 deg. or 300 deg. C. (480 deg.—570 deg. F.) no marked change is to be noted in the visible microstructure, even at very high magnification, although pronounced changes in the dimensions and density often do take place even at such low temperatures. Above 250 deg. C. the separation of the carbon-bearing compound, cementite, from the martensite begins and at 400 deg. to 500 deg. C. (750 deg.—930 deg. F.) the steel shows a very fine granular structure under the microscope. As the temperature of reheating is increased, the granules increase in size, although a high magnification is still required for seeing them, and the steel becomes softer and finally loses all of the high tensile properties it gained by the hardening treatment.

Hose-Clamping Press

IN most railroad shops it becomes quite a problem to keep the air hose in good condition for use in the various departments. New hose has to be fitted up, fittings which

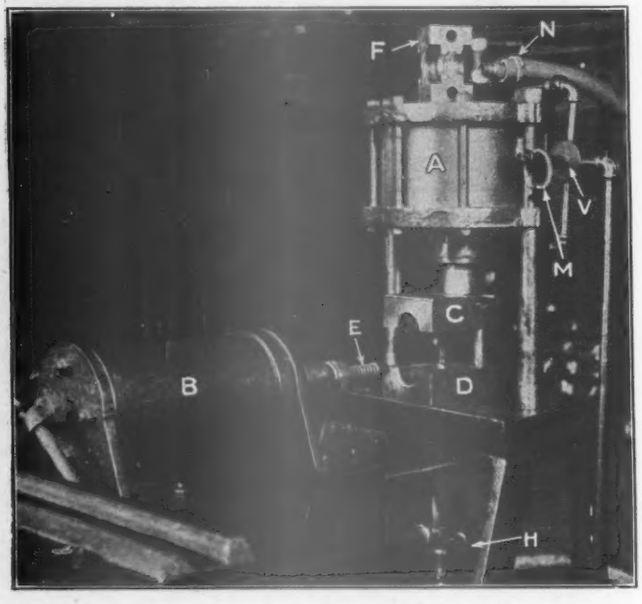


Fig. 1—An Effective Home-Made Hose-Clamping Press

have blown out reapplied, and defective hose sections cut out. This work is usually done in the toolroom and unless some labor-saving method is developed, one or more men will be employed continuously repairing hose.

A special hose-clamping press designed to facilitate hose repairs has been developed at the McKees Rocks shops of the Pittsburgh & Lake Erie as shown in Fig. 1. The device consists of an 8-in. cylinder *A* with an effective stroke of 2½ in. placed vertically in the frame work shown. The horizontal cylinder *B* is 4½ in. in diameter with an effective stroke of 6 in. Both of these cylinders are rigidly fastened in the frame work, being operated by three-way valves, one of which is shown at *V* and the handle of the other at *H*. The piston in cylinder *B* is returned after each stroke by means of a spring.

In assembling the nut and swivel in a length of hose,

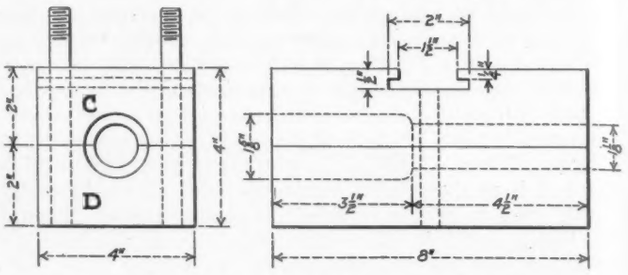


Fig. 2—Dies Used in Assembling Hose and Fittings

the dies *C* and *D*, shown in detail in Fig. 2, are used, the nut and swivel being held on an extension of the piston rod at *E*. The hose is next placed between dies *C* and *D*, being firmly gripped in the smaller section of the die at the right as soon as the dies come together. Operation of cylinder *B* forces the swivel *E* into the hose with far less effort and in a much shorter time than could be done by hand.

It also enables a relatively larger swivel to be forced into the hose than would be otherwise possible and the result is that when the clamp is applied there is less chance of a leak.

The hose, swivel and nut being assembled, the next operation is to apply the clamp. The more common form of clamp consists of some form of circular band usually tightened by means of a small bolt and nut. The practice at McKees Rocks is to substitute for this clamp one made of ¼ in. round iron long enough to go completely around the hose and lap over possibly one inch. Such a clamp before and after application is shown at *M* and *N* in Fig. 1. To apply this clamp, dies *C* and *D* are removed from the machine, dies *F* and *G* being substituted. The construction of these dies is clearly evident from Fig. 3, and their operation by means of cylinder *A* presses the clamp firmly about the hose, when it has sufficient stiffness to resist any tendency of the nut and swivel to pull out.

Two sizes of hose, namely the ½ in. and ¾ in., are used, necessitating two sizes of each pair of dies. The clamps are

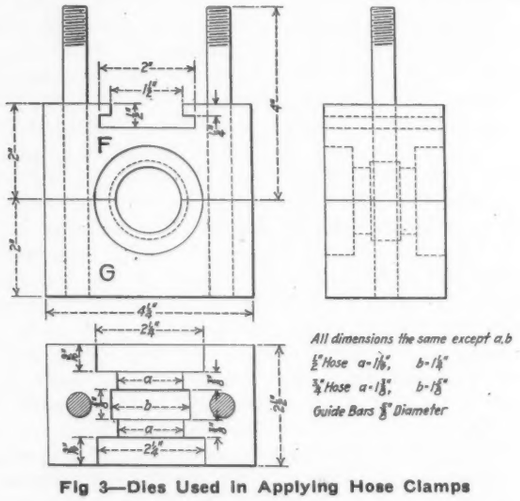


Fig 3—Dies Used in Applying Hose Clamps

made out of ¼ in. stock, 2½ in. and 3⅜ in. long respectively, bent in a circular form as shown at *M*, Fig. 1. Before the use of this hose-clamping press it took one operator practically all the time to keep the hose repaired at this shop. One man can now do this work in about one hour a day.

Boring Cross Compound Air Compressor Cylinders

Need for Smooth, Accurate Cylinder Boring Pointed Out; Special Holding Bracket and Cutters Described

ONE of the railroad shop machining operations which requires a high degree of accuracy and finish is reboring worn air compressor cylinders. Unless these cylinders are true, and have a smooth finish, it will be impossible to fit piston packing rings in such a way as to avoid excessive air leakage past the rings and consequent loss of compressor efficiency.

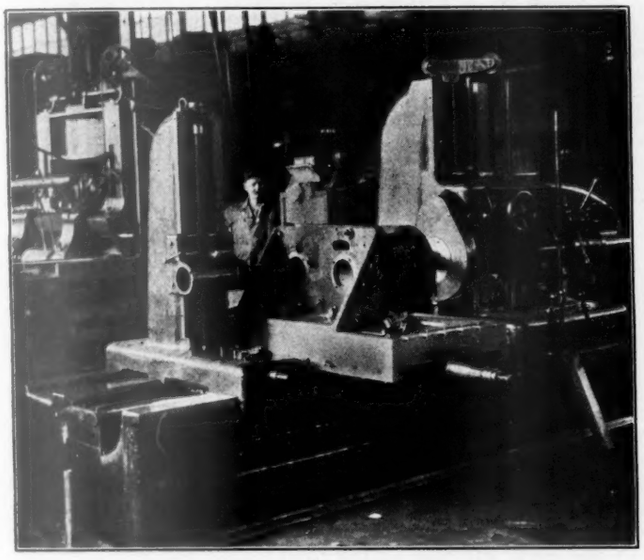


Fig. 1—Modern Boring Machine Set Up to Bore Air Cylinders

Strictly speaking, the re-truing of worn air compressor cylinders should be a grinding operation but if a suitable grinding machine is not available the next best type of tool for the job is a modern, heavy, accurate, easily-operated boring machine of either the vertical or horizontal types. Such a boring machine of the latter type is illustrated in Fig. 1, having been installed only recently in a prominent railroad shop.

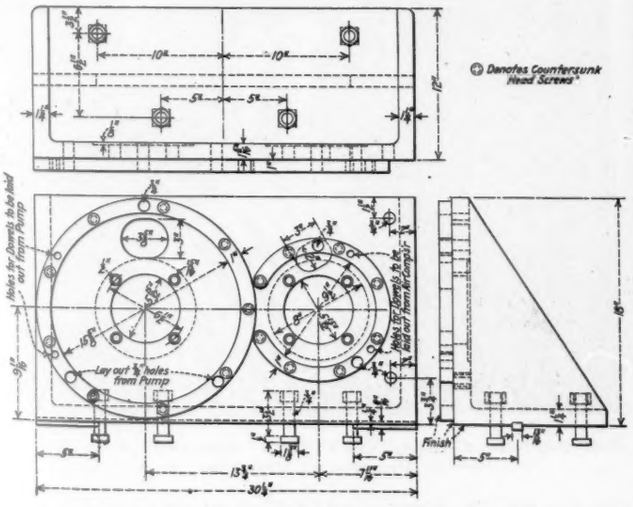


Fig. 2—Details of Cylinder-Supporting Bracket

In addition to air compressor cylinders being true and smooth individually, it is highly essential that the upper and lower cylinders be in exact alinement. Otherwise there will be trouble with piston packing rings and piston rod packing. Also, in the case of duplex and cross compound compressors, cylinder center lines must be the standard distance apart or the cylinders will not be interchangeable. Both of these difficulties were experienced on the railroad referred to, and by careful checking, it was discovered that the cylinders were frequently not in exact alinement and center lines not a standard distance apart, owing to an accumulation of errors in reboring.

As a result of this discovery, it was decided to bore air compressor cylinders on as modern and highly accurate a machine as there was in the shop, using a special cylinder-holding jig or bracket which would insure all cylinders being bored alike and according to the original standard. The machine selected for this job is shown in Fig. 1, with the bracket bolted to the work table and a cylinder in place ready for boring. Details of the bracket, designed to accommodate Westinghouse 8½-in. cross compound cylinders, are shown in Fig. 2.

Referring to Fig. 2, this bracket is cast in the form of a knee, the vertical face being planed square with the work table and maintained square with the boring bar by two 13/16-in. keys. The bracket is rigidly bolted to the work table by four ¾-in. bolts and nuts. The cylinder cannot be bolted directly to this bracket on account of the cutter bottoming, so one complete ring and a smaller partial ring of 1-in. square iron, accurately machined, are secured to the bracket by countersunk head screws as illustrated.

Four dowel holes in these rings, an exact reproduction of the dowel holes on a standard center casting, position the cylinder accurately with respect to two 5 15/32-in. center holes. These center holes are spaced 13¾ inches apart on centers, or the standard distance between high and low pressure cylinder center lines.

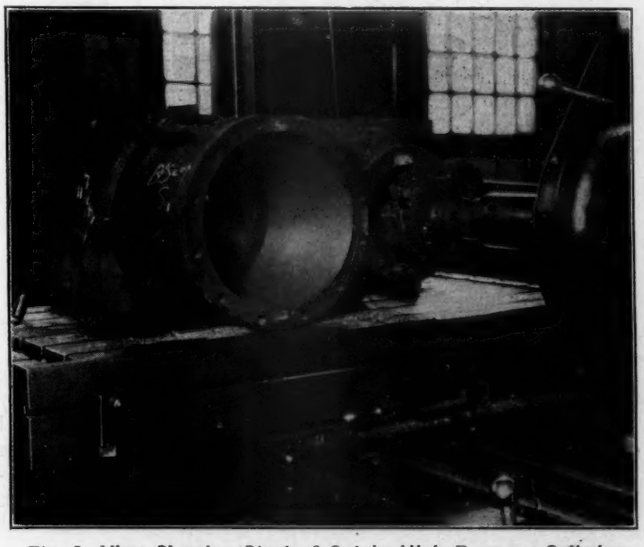


Fig. 3—View Showing Start of Cut in High Pressure Cylinder

From the foregoing it is evident that a machinist can quickly hoist a cylinder into place, position it on the dowels and bolt it to this bracket, being sure without any testing that it is square with the work table and the boring bar.

In addition, if the boring bar is centered in the 5 15/32-in. holes before boring, the resulting cylinders will be the standard distance apart and correctly located with respect to dowel and bolt holes. It was originally proposed to support the outer end of the boring bar in special bearings, bolted to the bracket and accurately centered in the 5 15/32-in. holes, thus avoiding any calipering whatever in the set-up. However, this practice was discontinued in favor of guiding the boring bar in its usual outboard support. In any case it is far easier and more accurate to center the boring bar in the correctly-located bracket holes rather than in large and frequently inaccurate cylinder counterbores.

Two special boring cutters are used on this job, a close-up of the bracket and cylinder with one of the cutters just starting a cut in the high pressure cylinder being shown in Fig. 3. Fig. 4 shows details of both the low and high pressure cylinder boring cutters. Referring to Figs. 3 and 4, the substantial construction of the cutters is apparent. They are designed with sufficient excess weight and strength to practically eliminate vibration. They are made of steel with four adjustable cutting tools, being keyed to the boring bar in each case by two large set screws.

As previously stated, the time of setting up air compressor cylinders on this jig is reduced to a minimum; the cylinders are set up accurately; and ample provision is made for centering the boring bar accurately. With substantial boring cutters, removing metal at four points simultaneously, the result is an extremely smooth and accurate cylinder. Two cuts are usually required, just enough material being removed to true the worn cylinders. It takes approximately

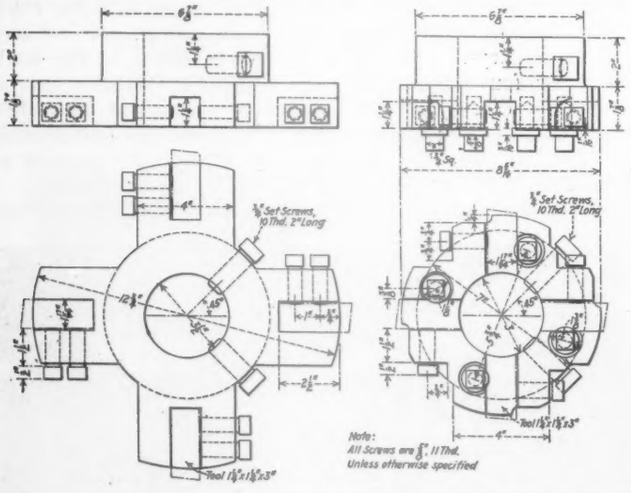


Fig. 4—Details of Low and High Pressure Cylinder Boring Cutters

two hours to set up and bore a pair of cylinders, a roughing and finishing cut being taken in each.

Difficulty in maintaining air compressor piston packing rings and piston rod packing has been largely overcome by boring cylinders in the manner described on the horizontal boring machine. This machine has also proved its value in the shop where it is installed by relieving a serious congestion of boring work. It is used for boring ash pan hopper cylinders, main extension driving boxes, side rod bushing holes and other boring jobs. It is also used occasionally with special forming cutters for machining steam pipe joints, milling piston rod keys and other similar work.

Machine-Forged Safety Chain Bolts

THE cost of forging safety chain bolts by hand in the blacksmith shop would be excessive and, inasmuch as large numbers of these bolts are required, it is a paying proposition to make special dies and manufacture them in quantity on forging machines. Standard safety chain bolts are thereby obtained at an important reduction in cost.

The right-hand half of a set of dies for making safety chain bolts is illustrated in Fig. 1 and a pile of finished bolts in Fig. 2. These bolts are made in a 2½-in. forging machine at the rate of about 30 per hour. The first operation, after cutting stock to the right length, is to heat and bend it by

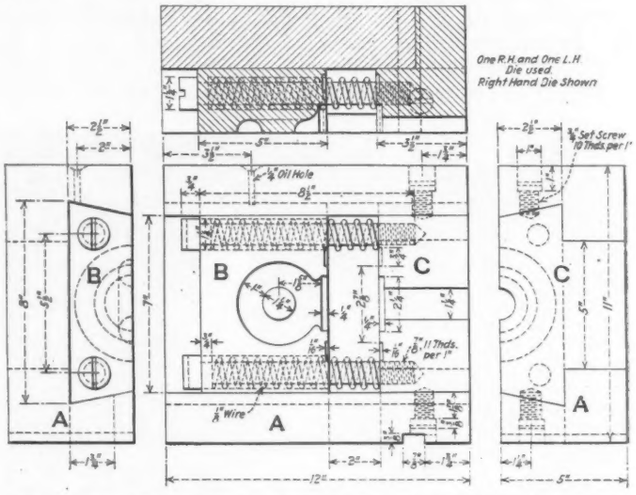


Fig. 1—Right-Hand Half of Die for Forming Safety Chain Bolts

hand around a suitable pin in an anvil, forming the eye, as shown by one of the vertical bolts in Fig. 2. The bolt is then reheated, upset in the forging machine and the collar welded and formed. At the time this photograph was taken the eyes were hand-formed, causing more or less variation in the stock left over at the bend. As a result, the forging operation left considerable flash which had to be removed with a handle chisel and sledge. By the use of a suitable pneumatic or power-operated jig for forming the eyes, the same amount of stock would be left over in each case and a practically perfect safety chain bolt with little or no flash could be secured.

Referring to Fig. 1 the construction and operation of this

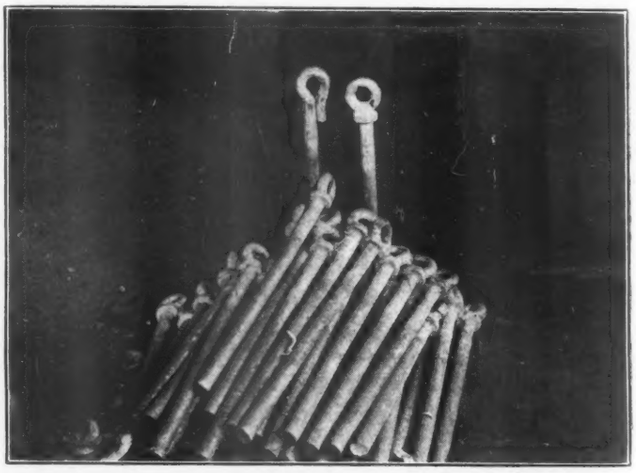


Fig. 2—Finished Safety Chain Bolts; One Bolt, With the Eye Formed Previous to Upsetting, Shown

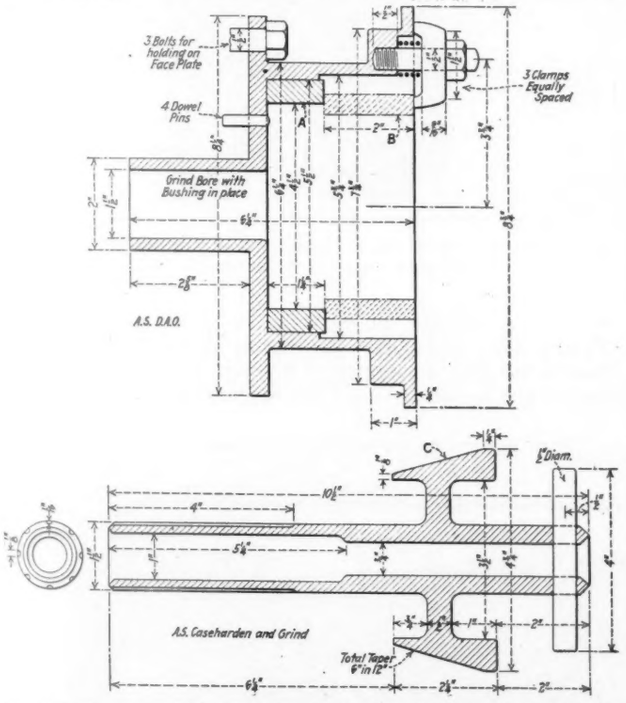
die will be evident. The right-hand half, illustrated, consists of body *A* with sliding part *B* to form the head of the bolt, and stationary part *C* to grip the stock while being upset. Part *B* moves in carefully fitted taper ways, being held by two ⅞-in. by 8½-in. filister head bolts and returned at the end of each stroke by the coil springs shown. An oil hole is provided by means of which sliding part *B* can be lubri-

cated, insuring its easy movement without sticking or undue wear.

Part *C* is accurately fitted to body *A* (shown by the right end view) and held securely to it by two ¾-in. set screws. It will be noted that the shoulder on the bolt is formed by a suitable recess, part of which is in *B* and part in *C*. In operation, the partly-formed bolt is reheated to a welding temperature and inserted in the forging machine with the eye in position in part *B*. The moving left-hand die (a counterpart of the one illustrated) moves to the right and grips the bolt at the shank between the two halves of part *C*. Operation of the forging machine ram then forces moving part *B* against *C* compressing and welding 2 in. of stock and forming the desired shoulder.

Internal Grinder Centering Chuck

THE drawing below illustrates an attachment for centering and holding bushings for internal grinding on a chucking grinder. The body of this chuck, which is bolted on the face plate, has three clamps as shown for holding the bushings. Removable rings inserted in the chuck provide the proper support for bushings of varying diameters and lengths. For example, ring *A* is the size used with bushing *B*. The arrangement for centering the bushings is especially interesting. The bushing is placed in the chuck and before it is clamped, the conical mandrel *C* fitting the bushing is inserted. This mandrel has a straight stem which fits an accurately ground center hole in the body of the chuck. As


3 Bolts for holding on Face Plate
4 Dowel Pins
3 Clamps Equally Spaced
Grind Bore with Bushing in place
A.S. D.A.O.
A.S. Caseharden and Grind
Total Taper 6" in 12"
1" Diam.

Special Chuck and Mandrel for Centering Motion Work Bushings To Be Ground Internally

the mandrel is pushed in, it locates the bushing, bringing it to a central position after which it is held by tightening the clamps. The mandrel is then removed and the interior of the bushing is ground.

Suggestions for Thermit Welding

THE following suggestions and recommendations not previously published in instruction books on Thermit welding will be of interest to welders engaged in making repairs to heavy sections made by this method. Locomotive frame welders in particular will find the suggestions of practical value.

Making Pattern Wax Plastic: In previously published directions for making plastic the yellow pattern wax to be applied between sections to be joined by Thermit welding, it was recommended that the wax should be placed in a pan and warmed until it became plastic, or else melted entirely and allowed to cool until it became plastic. Another way of making wax plastic, which has been found very satisfactory, is to pour the melted wax in a small stream into cold water. Very shortly thereafter it can be removed with the hands and the water squeezed out. It then will be found sufficiently plastic for use.

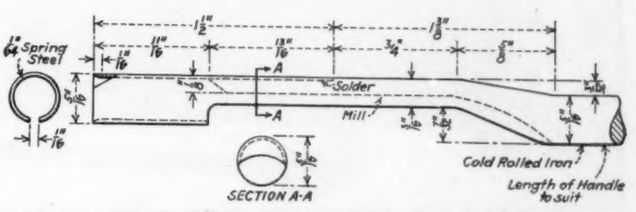
Connecting Top of Pouring Gate and Riser: After hollowing out a basin in the top of a rammed up mold, a channel or trough should be cut in the top surface of the mold, connecting the top of the pouring gate and the top of the riser. This will cause the first slag, overflowing on top of the mold, to quickly run across to the riser and thus while the metal is very liquid, equalize the pressure on the pouring gate and the riser.

Use Liquid Fuel, Not Gas, for Preheating in Thermit Welding: The use of gas for preheating in Thermit welding should be discouraged because in order to properly preheat a section in a mold without badly burning away the preheating gate, it is necessary to use vaporized liquid fuel (gasoline or kerosene) which can be blown into the mold as such a velocity that the location of the flame can be varied at will. Thus by increasing the velocity at the end of the burner pipe, the lower part of the frame can actually be cooled down and the upper part heated. The flame at all times can be so regulated that the heating gate will be dried out but will not be burned. This is not the case with any gaseous fuel, whether it be natural gas or illuminating gas, etc., and in all such cases the flame will either start at the end of the burner pipe, or will be blown completely out. This mass of flame passing continually through the restricted heating gate during the entire preheating operation is bound to do considerable harm, and in all cases the lower part of the mold and the section being preheated will be at considerably higher temperature than the upper parts.

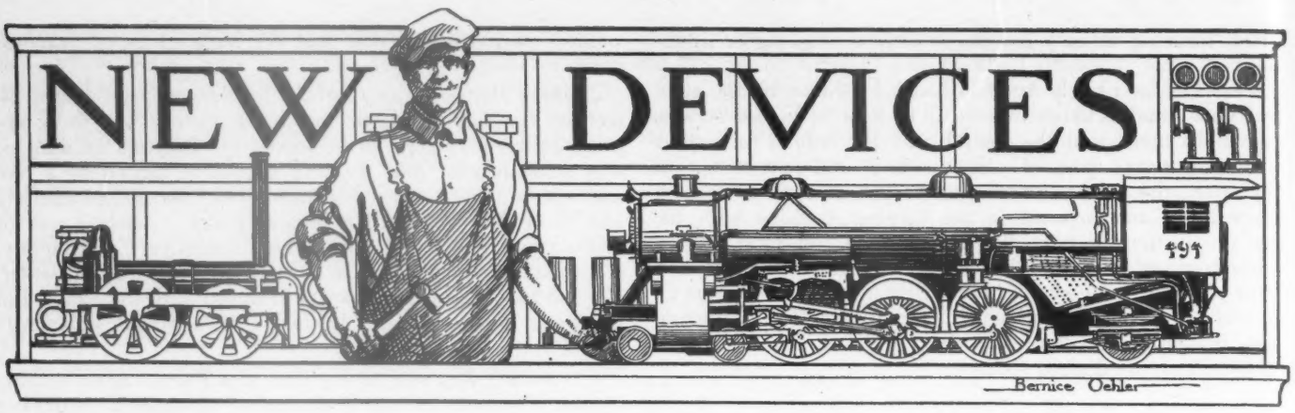
Character of Flame in Preheating: Too rich a flame during the early part of preheating may not be harmful, but especially toward the end care should be taken that no excess oil be used, so that the lean flame will tend to burn out from the molding material any oil which may have penetrated during the early part of the preheating.

Removing Reversing Valve Rods

ANYONE who has been obliged to take off the cylinder heads and piston head and take out the piston of an air compressor in order to remove a broken reversing valve rod, will appreciate the value of the device shown in the illustration. This is designed so that it can be inserted in the hole in the piston rod. The circular piece of spring steel on the end, when forced over the end of the valve rod, clamps it securely so that it can be easily taken out.



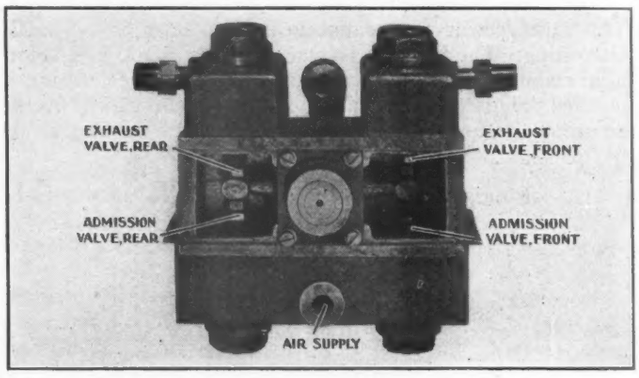
Convenient Device for Removing Broken Air Compressor Reversing Valve Rods Without Taking Off the Cylinder Heads



All-Service Locomotive Power Reverse Gear

THE All-Service power reverse gear is the result of developments extending over a period of about four years, during which the designers, the Transportation Devices Corporation, Indianapolis, Ind., carried on an extensive investigation covering all phases of the reverse gear problem. The concrete result has been the incorporation in this gear of certain features, the value of which has been amply demonstrated.

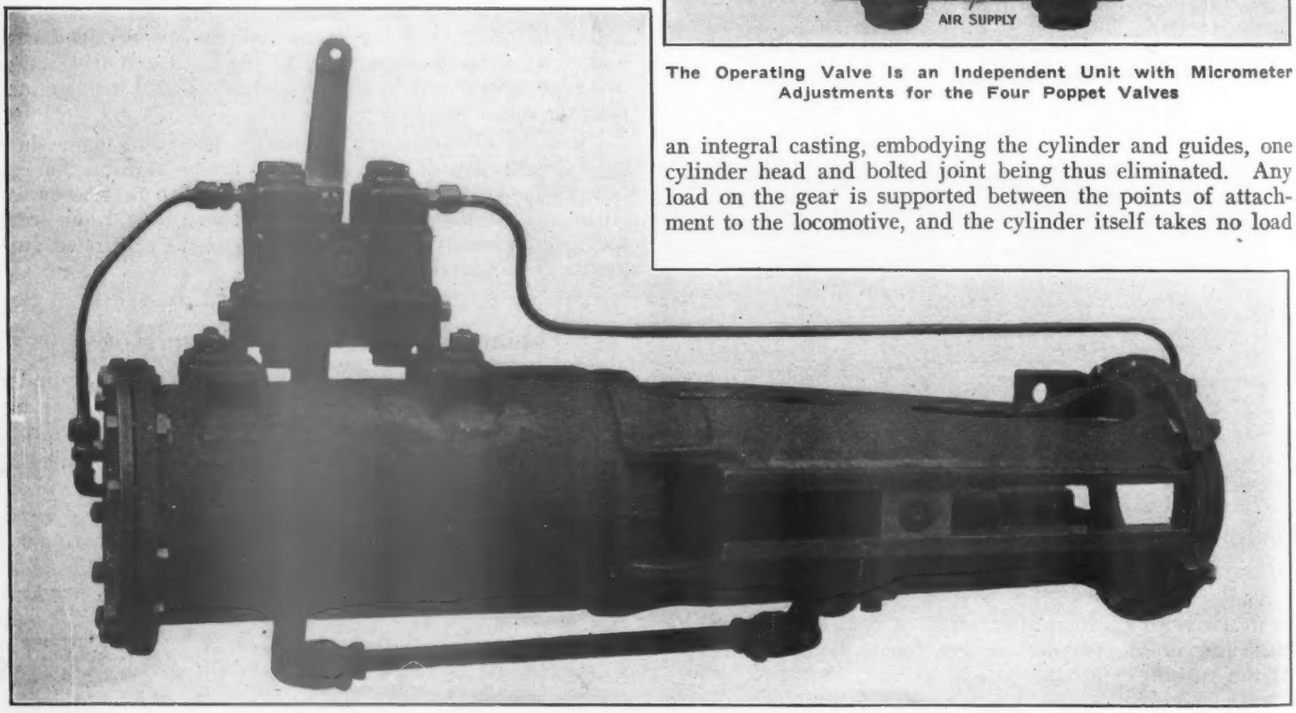
Desirable features of construction and operation claimed for the All-Service reverse gear include equal adaptability to passenger, freight or switching service, interchangeability with the majority of reverse gears now in service, and positive prevention of creeping. Fine adjustment, air cushioning is provided for passenger and freight service, and quick reverse, easy handling for switching service. In addition, stuffing boxes and glands are eliminated, and the operating valve is



The Operating Valve Is an Independent Unit with Micrometer Adjustments for the Four Poppet Valves

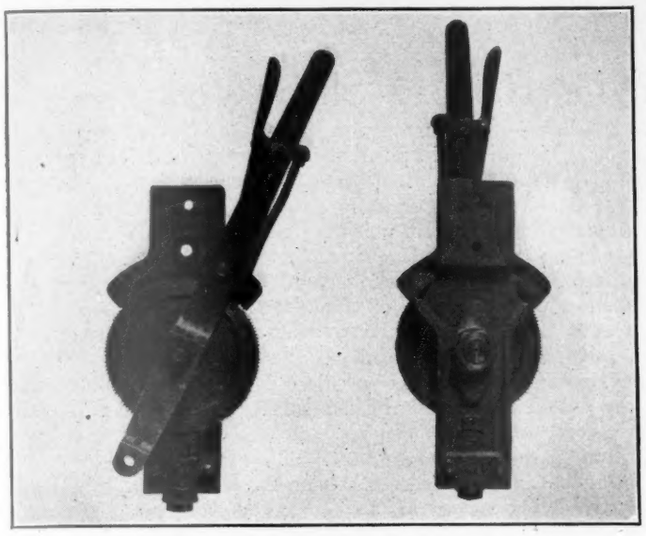
that in this respect the gears require no attention from the enginemen.

To obtain the above features, the body of the gear is made an integral casting, embodying the cylinder and guides, one cylinder head and bolted joint being thus eliminated. Any load on the gear is supported between the points of attachment to the locomotive, and the cylinder itself takes no load other than internal pressure. A floating cylinder, moving within the main body cylinder, and a fixed piston head are provided, thus eliminating the usual piston rod, crosshead, stuffing box and packing. By this construction the packings are readily removable for repairs without removing the entire gear from the locomotive. Many of the parts subject to wear can be obtained from standard stock always carried by the railroads. The provisions made for lubrication are such that in this respect the gears require no attention from the enginemen.



All-Service Power Reverse Gear with Cylinder and Guides on Integral Casting

ing rings, or sealing medium, are subjected to air pressure in one direction only for each of the air pressure chambers of the gear. This permits employing the same methods and materials in successful use for years in packing air brake cylinders; cylinder leakage is reduced to the minimum; and



Reverse Lever with Fine Tooth Circular Quadrant

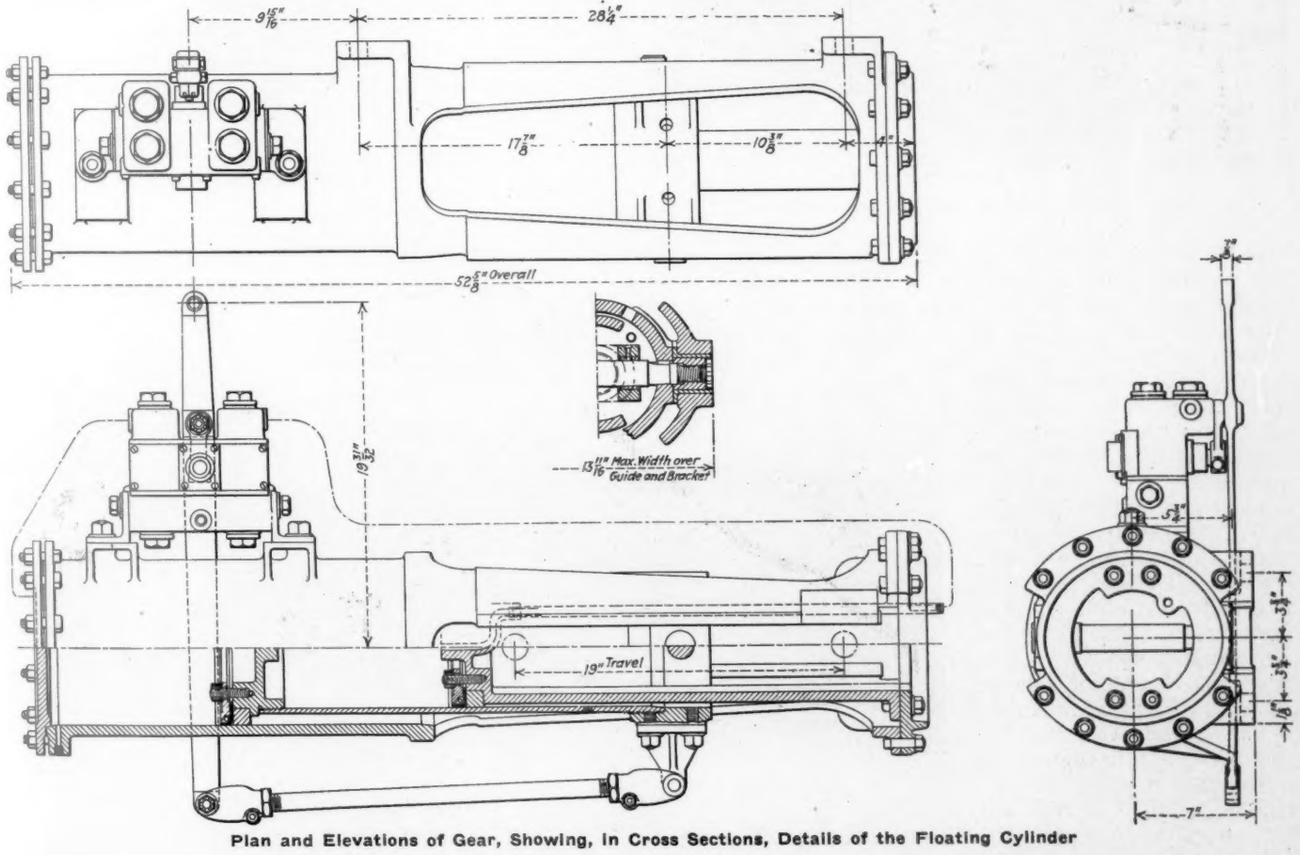
there is no possibility of air leaking from one pressure chamber to the other. Furthermore, the absence of any piston rod or stuffing box as a contributory cause for leakage

this gear, hardened steel pins and bushings are used throughout, all fits being ground. To insure long life of cylinder packing cups, the cylinder walls are also ground surfaces. Maximum accuracy and smoothness are thereby obtained with the reduction of air leakage to practically nothing.

The operating valve is applied as an independent unit on the gear, performing the same function as the triple valve with respect to the brake cylinder or reservoir. The four-poppet valve principle is employed to give long life to valves and allow separate adjustments of exhausts and admissions for each of the two air chambers. Micrometer adjustments are provided for each poppet valve to allow of independent clearance, or no clearance at all, and to make the gear sensitive to any adjustments that may be required, either because of the gear moving itself, or being moved by the engineman. It is apparent from the illustrations that this valve can be readily removed and taken to a bench for repairs, another valve being applied in the meantime without disturbing the gear or unduly delaying the locomotive.

Some unusual features are included in the reverse lever and especially the quadrant. A circular quadrant without stops is used to insure full travel of the level. The wear of the quadrant teeth with corresponding lost motion of the lever is compensated for in revolving a new set of teeth to the operating arc of the lever. V-notched teeth are used to make available a large number of adjustments. The notches and quadrant latch are so designed that the reverse lever can be placed in any cut-off position desired. The fineness of adjustment is determined by the fineness of the engineman's movement of the lever.

The valve and lever construction is such that the speed of the reverse gear crosshead is proportionally the same as the



Plan and Elevations of Gear, Showing, in Cross Sections, Details of the Floating Cylinder

makes the gear proof against creeping due to instability of pressures.

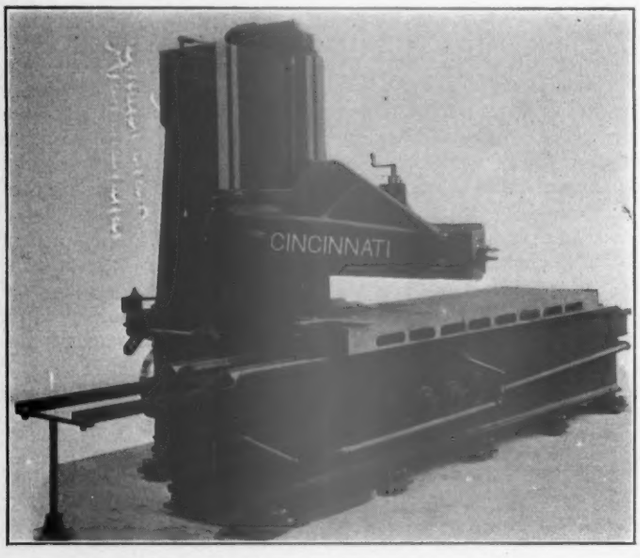
Lost motion of connection levers and bearings is one contributory cause to inaccurate reverse gear operation and in reverse lever, preventing "slamming" in reversing and "surging" when the slack is taken up. The pull on the reverse lever need be no greater than can be exerted by one hand, sufficient to open the valves, the power of the gear moving

the lever. The air consumption is reduced to that required to fill the increment of volume from which the gear is adjusted. This reverse gear can be readily applied to locomotives with either high or low-hung reach rods, and it is especially designed to work with automatic control of cut-off.

Continuous service for three years without attention of any kind is the record established by one installation of All-Service gear. This gear is in service on high-speed Atlantic type passenger locomotives where convenience of adjustment and stability of cut-off are particularly essential. Several gears have been in use a shorter period and as yet have required no adjustments.

Open-Side Planer Adapted for Railroad Shop Work

ESSENTIAL features of modern planer design are included in the 30-in. by 30-in. open-side planer, illustrated, which has recently been added to the line of machines made by the Cincinnati Planer Company, Cincinnati, Ohio. This planer is well adapted for work in railroad shops because of its power, generally rugged construction, variable cutting speeds, and rapid and easy manipulation in all working parts. In addition it handles an unusually wide range of work for its weight, owing to the open-side feature enabling parts to be machined which would not pass between the housings of an ordinary double-housing 30-in. planer. When planing work very much wider than the table, the use of a supplemental rolling table is recommended.

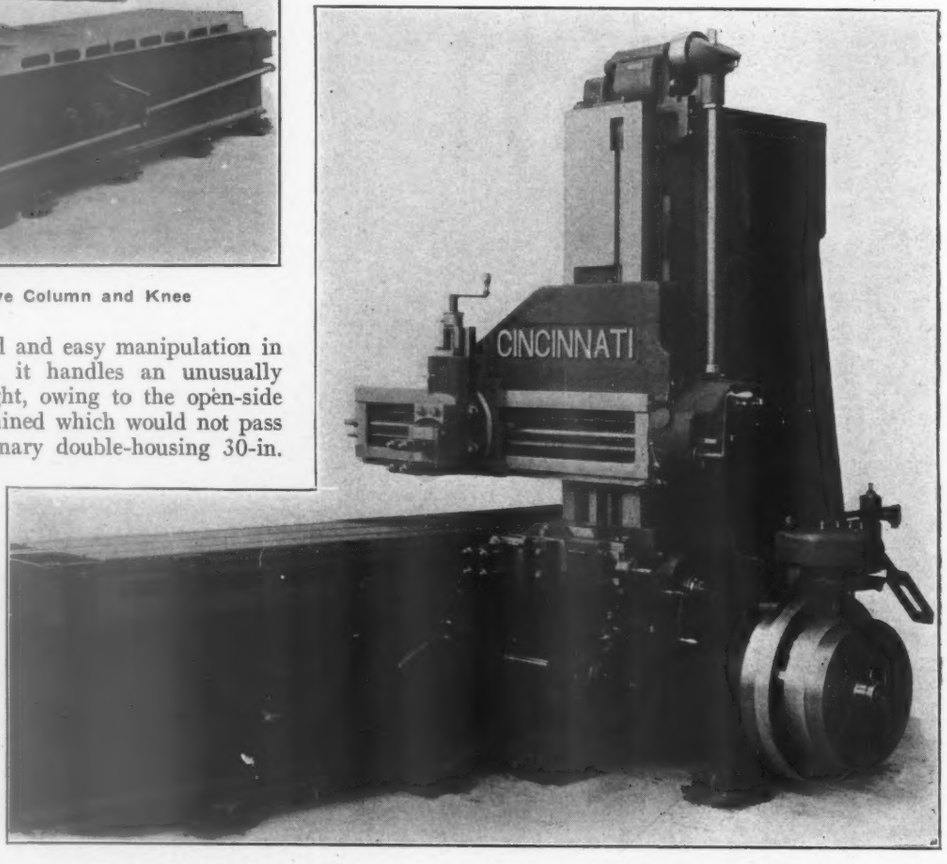


Rear View Showing Massive Column and Knee

Referring to the front-side view, the rigidity and convenience of this design will be evident. The extra-capacity box table is gibbed down to prevent tilting when carrying an over-hanging load. The table also fits down between guides to prevent being pushed sideways while cutting. The rear view clearly shows the massiveness of design and the unusual depth and width of the column. The knee, supporting the rail, is also rigid.

The patented Cincinnati Tu-Speed drive is used with this machine, giving two cutting speeds and a constant return. Where a greater number of speeds are needed, variable speed reversible, or non-reversible d.c. motor drive can be furnished. Rapid power traverse is provided for the rail head, placing it quickly in position without fatigue to the operator. This arrangement is fool proof in its operation and ready for use at all times. Forced lubrication is supplied to the vees directly under the tool point by means of a pump and piping system, partially shown in the rear view. From here it is distributed over the entire length of the bed to either end, then returning to the oil tank by the pipes shown. This feature is especially desirable when the table is making short strokes, or is heavily loaded.

Herringbone gears are used for the first gear reduction on the pulley. The bull wheel revolves with the shaft in bearings of ample proportions, and accurately-cut gear teeth throughout promote smoothness of operation. The cross rail is bolted and doweled securely to the knee, being raised and lowered by means of a patented power-elevating device, operated through frictions controlled by a lever on the right side of the column. A feature of the head is the round tool block and slide which avoids projecting corners on angular work. The head is carefully scraped to the rail and is graduated for swiveling up to 90 deg. It has automatic feeds and rapid power traverse in all directions and can be operated from either side of the machine.



Front-Side View of New Cincinnati 30-In. by 30-In. Open-Side Planer

The side head has a long narrow guide for the saddle on

the column, and the handle for vertical movement follows the head. Independent adjustable power and hand vertical feed are provided and the side head can be run down below the top of the table when not in use. The counterbalance system is self-contained and there is a releasing latch for the tool block. Micrometer dials are furnished on all down feeds and cross feeds. These dials are graduated in thousandths, a great convenience in obtaining depths of cut accurately and rapidly. The feed device is a new design with the trigger and spring mechanism enclosed.

The shifting mechanism transfers the belts quickly and practically without noise when running at high speeds. Wide belts and proper speeds insure abundant power and accurate strokes. Quick reverse aluminum pulleys are used and greatly reduce the power required at the moment of reverse, also increasing the efficiency of the planer. All loose pulleys are provided with new and improved self-oiling bronze bushings.

This planer, with a table 8 ft. long and a 13-ft. bed, will plane 31 in. under the knee and square down 31 in. in width. For motor drive, a 10-hp. motor with a maximum speed of 700 r.p.m. is required.

Twenty-Inch Coneless Engine Lathe

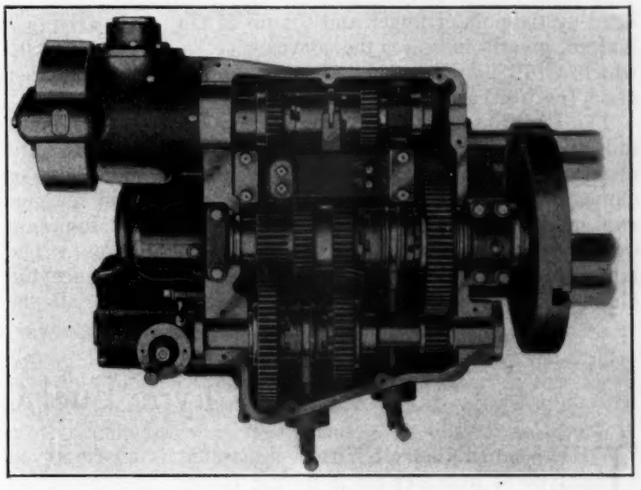
AN important addition to the family of modern engine lathes has been made by the Boye & Emmes Machine Tool Company, Cincinnati, Ohio, in the 20-in. engine lathe illustrated. This lathe, known as the coneless rather than geared head type, is a compact motor-driven unit of extremely pleasing proportions. All working parts of the lathe are designed with sufficient weight and strength to resist stresses occasioned by taking heavy cuts with modern high-speed steel tools. Accuracy is secured by careful workmanship, and the location of all operating levers and hand wheels is such that the machine may be accurately described as a production tool. In this connection it should be noted that the main spindle can be started and stopped or reversed by either of two handles on the same controller rod, one handle being at the end of the head stock and the other at the right-hand end of the carriage.

The head stock cover is made in a single piece and a view of the gearing with this cover removed is shown in one of the illustrations. This view shows the arrangement of the shafts, clutches, gears and levers for speed changing. All levers are either drop forgings or steel castings. The main spindle bearings are adjustable without removing the top cover. The head stock has a glass tube showing the oil level, which should be maintained at about one-half a glass. It is recommended that oil in the headstock be renewed every 60 days.

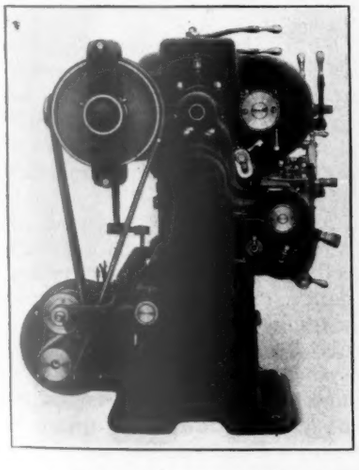
Twelve selective main spindle speeds are available on this lathe, 13 gears being used. These gears are always in mesh, running in an oil bath and it is impossible to engage conflicting gear ratios. The only frictions used are at the initial driving pulley shaft. The design of the tailstock is such that the compound rest may be swiveled parallel with the shears. Side set-over for taper turning is provided.

The apron is of the double plate type, affording bearings for both ends of the shafts, studs, etc. Longitudinal and cross feeds are engaged with frictions, and all feeds reverse in the apron. The mechanism is so arranged that longitudinal and cross feeds cannot be engaged when screw cutting. The lead screw is turned and ground before threading, which is done on special lathes. All threads shown on the index can be cut without the removal of gears, 40 standard threads, varying from 2 to 56 per in. being available. The construction permits of changing stud and intermediate gears, allowing odd threads, not shown in the index, to be cut. By transposing gears, metric pitches can also be cut.

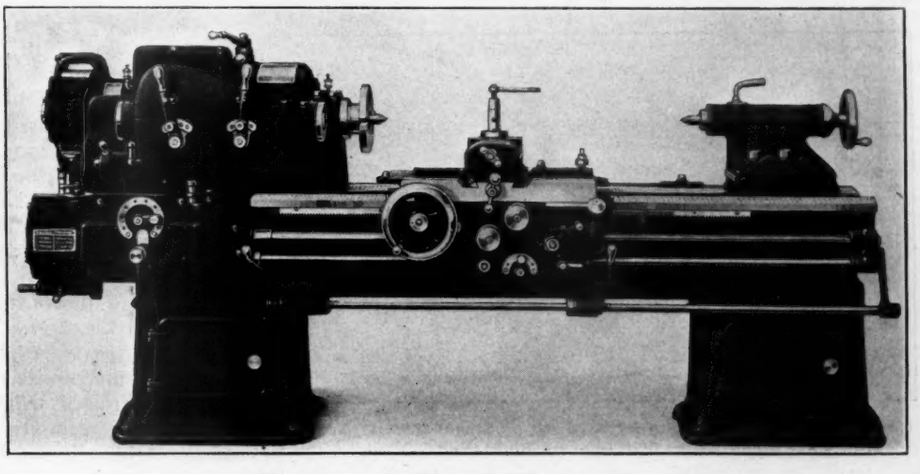
A special feature is the arrangement of the driving motor



Headstock with Cover Removed Showing Gearing Arrangement



End View Showing Motor Drive



Boyle & Emmes 20-In. (Coneless) Engine Lathe—a Compact Production Tool

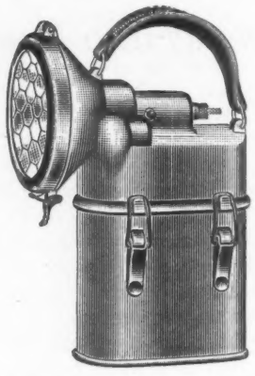
on a motor base plate attached to the cabinet leg. This motor base plate carries an idler pulley, running on SKF ball bearings, and providing proper belt tension. Any standard constant speed motor of from three to five horsepower can be used. The motor speed should not in any case exceed 1,200 r.p.m. With a 13-in. driving pulley, running at 350 r.p.m., the minimum main spindle speed is 10 r.p.m. and the maximum 332 r.p.m.

Convenient Type of Electric Dry Cell Lantern

IN the Excellite, developed by the National Marine Lamp Company, Forestville, Conn., the portable electric lamp has reached a high stage of development. It embodies features of safety, rapid and powerful illumination, and convenience of handling far exceeding the old fashioned oil lantern. A powerful ray of light, generated by two No. 6 dry cells contained in the aluminum casing, is made available, and an adjustable focus permits either a spread of light, or a piercing ray to be thrown a distance of six or seven hundred feet.

A push button switch, arranged to be instantly manipulated by the pointer finger and thumb of the hand carrying a lantern, greatly increases the convenience and quickness with which a full light can be obtained, besides leaving the other hand free for carrying other materials.

The Excellite is said to be absolutely fool proof and almost indestructible, having been dropped and thrown on hard materials without impairing the working of the light or damaging the lantern in any way. The bell-shaped reflector and small light bulb are amply protected in the aluminum casing by a ¼ in. wire-reinforced glass in the front. The lantern is also water-, moisture- and air-proof, since the aluminum casing completely encloses and protects all the vital parts. Recharging or installing new batteries requires about one minute's time, all connections between the light switch and battery terminals being instantly made when the top section of the lantern casing is set in place on the lower section. Four spring clamps, two sets on each side, hold the two sections of aluminum casing together. A soft fiber gasket between forms a leak-proof joint. Two extra light bulbs are furnished with the Excellite, these being held neatly in place by small spring cribs inside the top section of the casing.

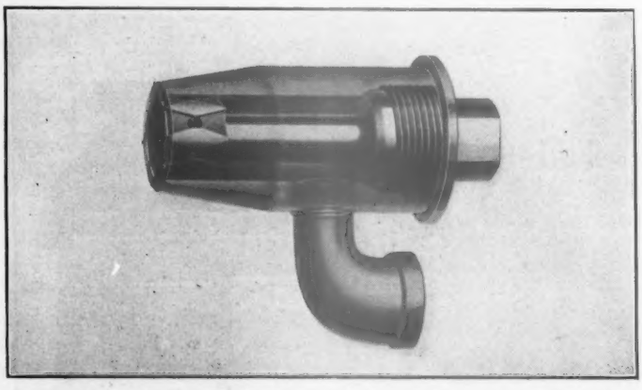


Excellight Electric Lantern

Many uses for this hand electric lantern are readily apparent since it performs in a more efficient way the function of the old style lantern and in addition can be used with safety around all kinds of inflammable and explosive materials and gases.

Venturi Type Fuel Oil Burner or Atomizer

THE Venturi fuel oil burner illustrated is an improved type of atomizer made by the Hauck Manufacturing Company, Brooklyn, N. Y. It is said to atomize or break up completely oil or even tar into finely divided fog-like particles by means of steam or compressed air. The burner consists essentially of a cylindrical casing with slots parallel to the bore axis. These slots form with the inner wall of the casing longitudinal ports or orifices through



Hauck Venturi Type Oil Burner with Air or Steam Inlet at Bottom and Oil or Tar Inlet at Right End

which the atomized oil is impelled into the furnace. Each port or orifice is a small Venturi tube constricted at its center and flared outwardly at the two ends. The throats or constricted parts of the orifices are connected with the interior of the bore by means of correctly-designed radial openings or apertures.

The oil or tar is delivered under a pressure of 40 to 60 lb. per sq. in. to the bore, and then passed through the radial apertures to the orifices where it is collided against and blasted by the compressed air or steam. The compressed air or steam is delivered to the burner at about 80 to 100 lb. per sq. in. pressure. As it flows through the ports, its velocity increases rapidly and becomes a maximum at the orifice throats. Here it strikes and blasts the oil, atomizes it thoroughly and impels the atomized oil from the burner orifices.

The Hauck Venturi oil burner is designed to secure a thorough mixture of the air and atomized fuel oil at the mouth of the burner. It is correctly proportioned to the oil and steam or air pressures available. It is readily accessible for purposes of cleaning and inspection, and can be removed from the furnace without affecting the operation of any other burner served by the same piping system.

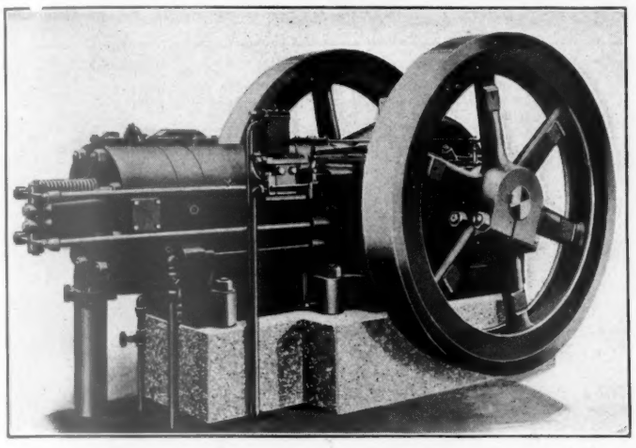
Reducing, neutral and oxidizing flames are obtained by manipulating the oil and air valves. The furnace atmosphere is thus closely controlled. With combustion taking place close to the burner nozzle, oxygen cannot come into contact with the steel. This results in less scaling. Decarburizing of the work is reduced and there is less spoilage and greater uniformity of product.

Close control of temperature is said to be accomplished with ease and certainty. The temperature of the furnace is controlled through two standard valves reducing labor and attention required to a minimum. Uniform combustion conditions and ready, exact and simple temperature control increase the efficiency of production. Fewer demands are made upon skill and judgment in the handling of the furnace and more time and attention can be devoted to the work itself.

The Hauck Venturi oil burner is adapted to a wide range of work, including use with all sorts of forging, annealing and heat treating furnaces; also heating and welding torches.

Direct-Injection Oil Engine Drives Compressor

THE Price horizontal direct-injection oil engine, manufactured by the Ingersoll-Rand Company, New York, employs the Price system of fuel injection which eliminates the need for a three- or four-stage 1,000-lb. pressure injection air compressor with intercoolers. A pump of single design provides the force for introducing the fuel into the combustion chamber. Two spray nozzles are employed, so arranged that their sprays impinge. The head



Ingersoll-Rand 17-In. by 19-In. Type P Oil Engine

and combustion chamber are shaped so that their surfaces are at all points parallel to the sides of the fuel sprays, thus preventing the fuel fog from coming in contact with a metallic surface where it would collect as drops and result in imperfect combustion.

The Diesel engine has long been regarded as the most economical and efficient prime mover and the Price oil engine is to all intents and purposes a Diesel engine. The elimination of the air compressor, however, is said to increase the mechanical efficiency 10 to 12 per cent, holding the fuel consumptions to .38 or .39 lb. per brake hp. hr. The former figure means that 20 hp. hr. can be obtained from a gallon of standard fuel.

Ignition, as in the air injection Diesel engine, is obtained by the heat of compression. All parts of the head, combustion chamber, and cylinder which are exposed to the gases of combustion are completely water-cooled. No flames, coils or exterior heating devices of any sort are required either in starting or during operation.

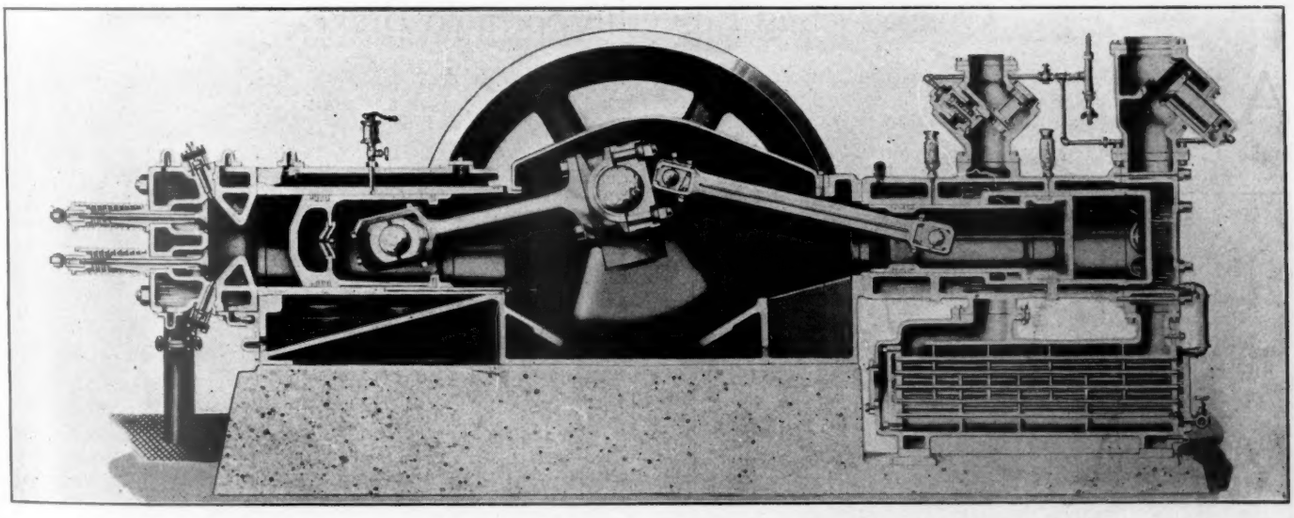
A number of the details of construction are worthy of mention. The exhaust and intake valves (the engine operates on the four-stroke cycle) are actuated by push rods from cams. The latter are housed in a compartment case in the engine frame, which protects them from injury and also permits of keeping them flooded with lubricating oil.

The crank case is closed by means of a cast-iron cover, the joint between the cover and the engine frame being machined and further sealed by means of a cord gasket. Every precaution is thus taken to prevent the waste of lubricating oil, one gallon being sufficient to lubricate the engine while delivering 4,000 hp. hr. The use of a trunk piston has shortened the overall length of the unit at the same time reducing the horizontal inertia forces. Even when developing full power, there is said to be no perceptible movement.

Important advantages claimed for the Price oil engine are simplicity, sturdy construction, accessibility of parts, fuel and lubricating oil economy and completeness of combustion.

Oil Engine Air Compressor Unit

One of the first applications of the Price direct-injection oil engine has been to drive a direct-connected air compressor unit. This unit, of which the 100-hp. engine forms the prime mover, has the air cylinder in line with the power cylinder but on the opposite side of the crankshaft. For 100 lb. pressure, a two-stage air cylinder is offered. The air intercooler is mounted below the air cylinder and forms a support for it. The general impression given by the unit is one of symmetry, compactness, and durability. For air pressures less than 100 lb., a single stage air cylinder is offered, which is connected to the oil engine frame by a distance piece. For both single and two-stage work, the air cylinder is double acting which has contributed to the exceptional balance of the machine.



Cross Section of Two-Stage Compressor Unit Driven by Direct-Connected Oil Engine

In the 50-hp. size, the air cylinder is vertical and is mounted on top of the engine, immediately above the crankshaft. By so doing, it has been made possible to mount the unit on a flat car or truck for use in portable work. This construction has not resulted in excessive height, this being kept less than 8½ ft.

The manufacturers have collected some important data

on the cost of producing air with these oil engine driven units. Allowing for the greater first cost it is said that air can be compressed with fuel oil at six cents a gallon on a par with electric power at 1¼ cents per kw. hr. With the fuel at 12 cents a gallon, the equivalent cost of electric power is 1½ cents per kw. hr.

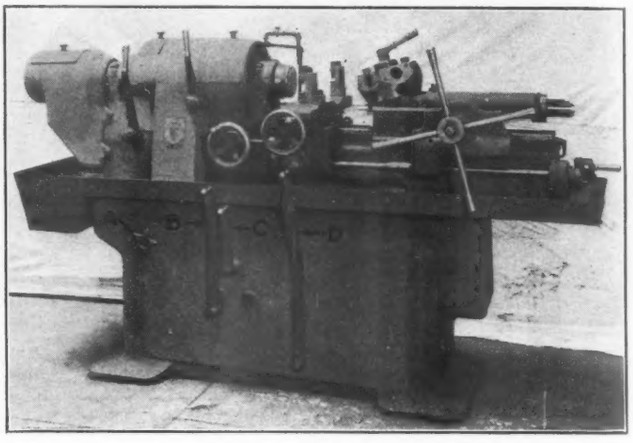
Motor-Driven Turret Lathe or Screw Machine

MADE by the Wood Turret Machine Company, Brazil, Ind., the turret lathe or screw machine illustrated has been provided recently with a self-contained, electric driving unit. The machine is now mounted on a cabinet base with the motor on the rear cover plate inside of the cabinet. The removal of this plate takes the motor with it. A silent chain connects the motor with the main drive shaft in the center of the cabinet. A cone friction clutch of the full floating type is used, the drive passing through a change gear box with gears running in oil and giving six changes of spindle speed on a plain head machine. Twelve changes are available on a friction back-geared machine. Twice as many speeds are thus obtained as on the regular belt drive, with the additional advantage of a reverse for every forward speed, accomplished through a patented reverse gear running in oil.

Power from the gear box is transmitted by a 12-in. diameter pulley and belt to a 12-in. diameter pulley on the spindle. A suitable belt tightener is provided between. All controls are centralized in the operating position. Hand-wheel *A* controls the belt tightener. Hand levers *B* and *C* control the speed changes and hand lever *D* controls the starting, stopping and reverse.

The removal of the front cover (which is the entire front surface of cabinet) opens the cabinet, affording a full view of the motor-driven unit. Air holes in both ends of cabinet provide for ample air circulation for the motor.

This turret lathe is said to have all the desirable features of belt-drive together with the best features of an all-geared head single pulley drive. The belt pull is down in the headstock instead of up against the main bearing caps, a type of drive coming into more common use owing to its convenience and economy. The machine can also be driven by belt as

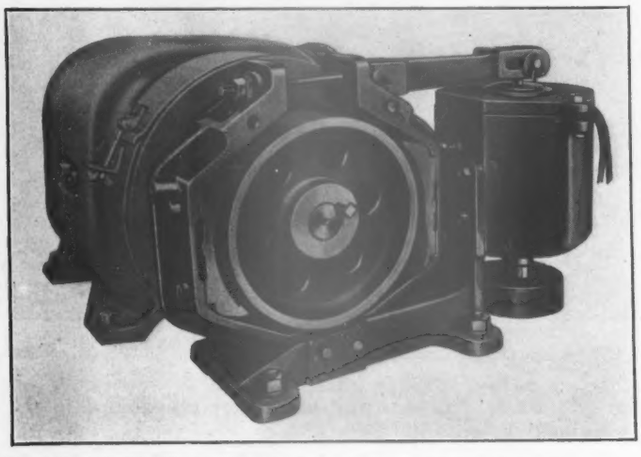


Wood Turret Lathe with New Electric Driving Unit

a single pulley drive by mounting a jack shaft on the rear cover plate in place of the motor. All revolving parts are guarded. The driving motor may be either d. c. or a. c. and either constant or variable speed.

Quick-Acting Powerful Solenoid Brake

A SOLENOID brake with important structural advantages for crane service has been developed recently by the Whiting Corporation, Harvey, Ill. This brake (Type C) is designed to be quick-acting, powerful,



Whiting Type C Solenoid Brake for Crane Service

provided with interchangeable parts and easy to adjust. The brake arms are so pivoted that the shoes release equally at all points and there is no chance of the shoes dragging at the lower end. This is also a big advantage in applying the brake, as the shoes bear equally at all points, resulting in quick braking action and uniform wear. All parts for the same size brakes are interchangeable. Brake wheels and shoes are interchangeable with like parts on the Whiting Corporation's standard foot brake.

It is necessary to change shoes from time to time and this can be done by simply removing four cap screws and sliding the shoe out. The brake shoes are of cast iron, filled with asbestos composition which has been thoroughly tested as to durability and ability to resist heat. Under ordinary conditions, adjustment of the shoes is required only once a month.

In the Type C brake all parts subject to stress are steel castings. For direct current the plunger is of soft iron of large diameter, which gives a fast operating solenoid, even at light loads. The solenoid spool is of brass tubing with a vulcanized fiber sleeve over the tubing and fiber ends. The coils, wound with asbestos-covered wire of ample size, are designed to operate the brake at about 40 per cent full load current and remain open at 10 per cent or less of the full load current. The voltage loss in the coil in most sizes averages less than 4 and in no case more than 7 per cent.

For alternating current the coils are wound with cotton-covered enameled magnet wire of ample size to carry the inrush current when the coil is energized. The plunger on the a.c. brake is of laminated iron of the proper thickness for the service intended.

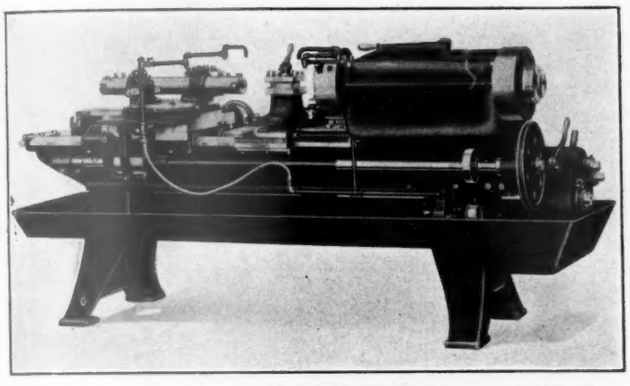
Before putting the Type C brake on the market, it was put through a series of exhaustive tests. A 12-in. brake was mounted on a 25-hp., 550 r.p.m., direct current motor. In

the complete test, the motor was stopped 50,000 times at a rate of 325 stops per hour, after which the brake is said to have showed no signs of wear except the usual shoe wear.

During this test a number of different lining materials were tested and the one selected showed the following characteristics: Material not affected when operating with the brake wheel at dull-red heat; average wear .0005 in. per 1,000 stops with motor running 1,800 r.p.m.

Fully Universal Flat Turret Lathe

THE illustrations show a No. 2 Cincinnati Acme flat turret lathe, made by the Acme Machine Tool Company, Cincinnati, Ohio, and designed to be fully universal by the addition of such distincttive features as a cross sliding turret and side carriage. These features provide for the operation of a large number of tools at one time, also making the tooling arrangement more simple and inexpensive.



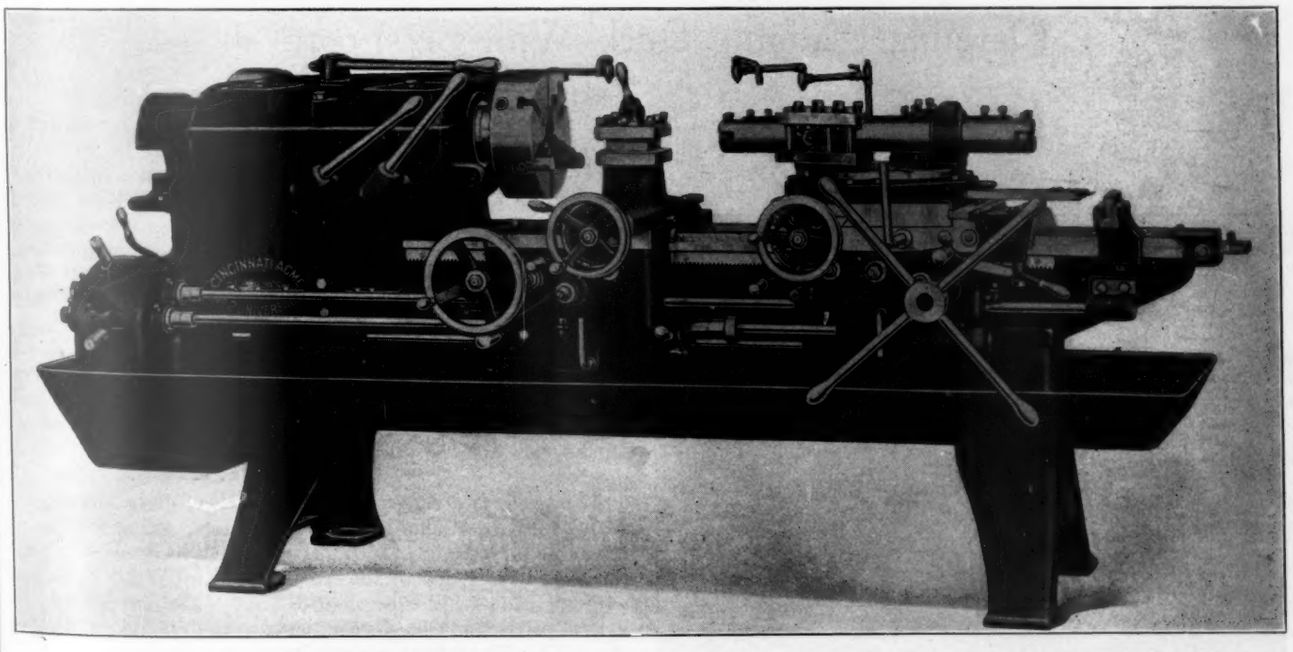
Rear View Showing Cutting Lubricant Pump and Piping

This machine, which will accommodate chucking work up to 20¾ in. in diameter, is designed for both bar and chucking work. For bar work either of two sizes of automatic chuck capacity can be furnished, 2½ in. or 3¼ in. The turret travel is 30 in. The square turret on the side carriage, together with the flat turret carriage, permits the maximum number of tools to be in operation at the same time, thus reducing cutting time to a minimum. The square turret may be used for undercutting, forming, facing and turning, while at the same time boring or turning with the flat turret. Independent feeds to each carriage provide separate power feeds to the square turret as well as to the flat turret.

An important feature of this machine is the centralized control, the time between operations being thereby reduced to a minimum. All control levers such as rapid traverse, cross and longitudinal power feed, spindle, speed levers, binder handles, etc., are directly in front of the operator. The all-geared head single-pulley drive provides 12 speed changes from 18 to 318 r.p.m. The stop and reverse lever is placed on top of the head stock as close to the operator's position as possible. By means of a patented gear-shifting device, it is possible to change from any one speed to another with one continuous movement of either of the speed change levers.

The side carriage spans the ways of the bed, eliminating overhang of the turret and tools. It is provided with six independent stops for the longitudinal movement. The square turret, mounted on the cross slide, can be indexed to four positions. The cross sliding turret revolves on a ground tapered stem of large diameter and is automatically locked in position. The cross slide moves on a long, narrow, dovetail guide with wide, flat bearing surfaces on either side, and has an adjustable taper gib to compensate for wear. The cross feed can be operated in both directions by hand or power.

Power rapid traverse is provided in either direction (longitudinally) for the turret. The operation of the control lever automatically disengages feed and power to the turnstile handle, making a fool-proof arrangement and providing a stationary turnstile wheel while rapid traverse is in motion. Twelve longitudinal stops are provided, one independent



No. 2 Universal Cincinnati Acme Flat Turret Lathe with Cross Sliding Turret and Side Carriage

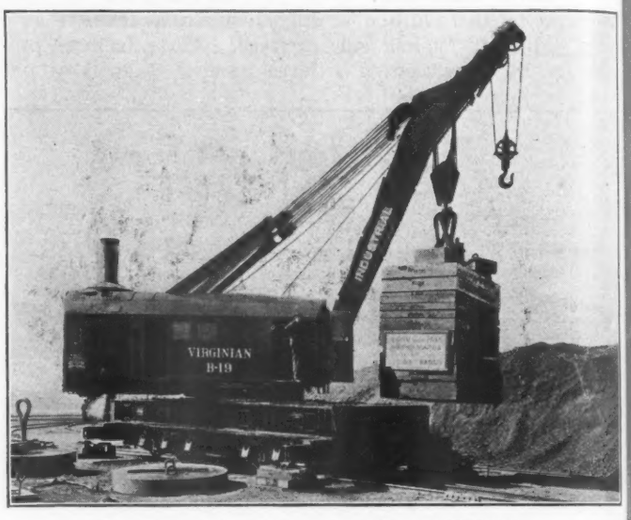
stop for each turret position and six auxiliary stops. These are operated by the index knob at the right of the saddle. A 5-hp. constant speed motor, running at 1200 r.p.m., is required. It is recommended that the motor be mounted on the rear side of the head end leg, thereby making the drive self-contained and compact. The change from countershaft to motor drive or vice versa can be readily made at any time.

Largest Wrecking Crane Placed in Service

THE Virginian has recently placed in service for use on its lines a new wrecking crane which it is claimed has the distinction of being the largest machine of the kind ever built. Heretofore, as far as is known, the largest railroad wrecking crane was a 160-ton machine having a maximum capacity of 320,000 lb. with all out-riggers in service. As compared with this, the new crane has a capacity on the main hoist of 400,000 lb. at a 17-ft. 6-in. radius with all out-riggers in service, a capacity of 200,000 lb. at the same radius with end out-riggers only in service and a capacity of 85,000 lb. at the same radius without the out-riggers. On the auxiliary hoist, the capacities are 90,000 lb. at 24 ft. to 30 ft. radii with the end out-riggers only, and 60,000 lb. at a 24-ft. radius without out-riggers.

In designing the crane, the main problem met was securing the 200-ton capacity required by the heavy rolling stock on the Virginian without exceeding railroad clearances and a maximum allowable axle load of 65,000 lb. on account of bridges. The crane in running order weighs 356,500 lb. and is mounted on special six-wheel trucks, the maximum axle load in running order being 64,000 lb. The car has a wheelbase of 26 ft. 2 in. and itself is 34 ft. long. The maximum height of the crane is 15 ft. 9 in. and the greatest width, 10 ft. 6 in.

The machine is equipped with a 12-in. by 12-in. engine operating on steam from a 65-in., 160-lb. A.S.M.E. boiler, and a Westinghouse air pump is provided, with clasp brakes on each of the 12 wheels. These brakes may be operated by the operator of the crane or by the engineman of the locomotive. All clutches are operated by air. The machine is a product of the Industrial Works, Bay City, Mich., and is said to have passed through all tests recently applied with ease and smoothness.



The New Crane Has a Capacity of 400,000 Lb.

Elevating-Platform Truck With Six-Foot Lift

AN elevating platform truck, known as the Hy-Lift, capable of hoisting a 4,000-lb. load 6 ft. from the floor, has been placed on the market recently by the Baker R. & L. Company, Cleveland, Ohio. This truck is intended for hoisting purposes, but is often used on short hauls. It will practically double and sometimes triple the capacity of store houses for heavy material. It can be used for loading wagons or freight cars and, in machine shops without crane facilities, is valuable for lifting heavy dies or parts to and from the machines.

Baker Hy-Lift Truck Efficiently Transports and Elevates Material

The new Baker truck is of rugged construction throughout, being interstandardized with previous models as regards motor, transmission, universal joints, wheels, tires, controller, etc. It is also equipped with the Baker duplex compensating suspension, described on page 257 of the April, 1921, issue of the *Railway Mechanical Engineer*. A two-cable hoist, either of the cables being strong enough to carry more than the rated full load, is used, and the advantages of the cable system of hoisting is especially important in this case where a long steel screw would be subject to dirt, abrasion and severe bending strains. This standard truck lifts 72 in. but trucks can also be furnished with 48-in. or 60-in. lift if desired.

The truck is arranged with a two-wheel drive and a four-wheel steering mechanism, providing for turning in a minimum outside circle of 107 in. With a load of 4,000 lb., the maximum speed of the truck is 4½ miles per hour, and without load, 6 miles per hour. The brakes are operated by a foot pedal and interlocked with an automatic switch and controller. The lifting speed without load is 11 ft. per min.; with 2,000 lb. load, 7 ft. per min.; with 4,000 lb. load, 5 ft. per min. The plate steel platform is hinged at the point of attachment to the roller head so that the tapered outer end of the platform tips if it catches when lowering the load. All parts of this truck are readily accessible for lubrication, adjustment or repair.

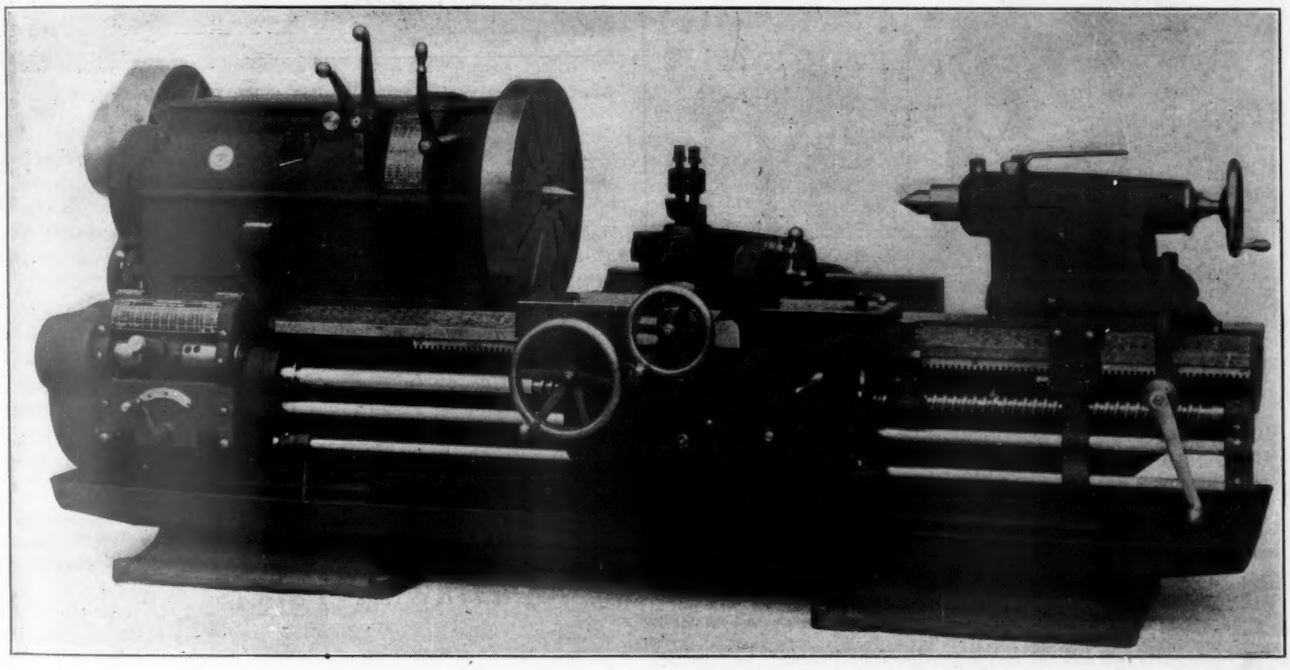
Heavy Duty Single Pulley Drive Lathe

A NEW heavy duty single pulley drive lathe, made in 25-in. and 27-in. sizes, has been brought out by the R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. Several distinctive features are embodied in this lathe, one of the most important being the arrangement of the selective geared headstock to provide 16 changes of speed by the simple manipulation of two levers. The speed changes are made selectively without the necessity of going through any intermediate speeds to obtain the desired speed. The drive is through an unusually large pulley with a high speed belt transmitting power from a 15-hp. motor. This motor is mounted on a hinged motor plate attached to the base of the lathe. The driving clutch is operated by a conveniently-placed lever at the front of the headstock and also by a lever on the carriage. It is of the powerful multiple disc type, running in oil.

The bed, headstock, carriage, and in fact all parts of the lathe have been designed for heavy duty. A new one-piece box section apron provides a definite increase in strength and rigidity with an important reduction in operating parts. By a special patented construction, both feeds are engaged with a single positive jaw clutch engaging the bevel gear, where it has light duty to perform. The feed control is said to be unusually sensitive and a positive trip lever is provided as shown on the front of the apron. The feed is driven by an independent feed rod and reversed by means of a shifting double bevel gear.

Another feature of the new lathe is the improved quick change gear mechanism of generally heavier design and greater driving power coupled with ease of operation. The range of threads and feeds has been selected to cover the usual requirements, and threads from ¾ to 46 per in. can be cut. The lead screw is new and considerably larger than those used previously. The thread is of special U. S. S. form, 1 in. pitch and 2 3/16 in. in diameter. It is finished in a special lathe fitted with a precision master screw. A chasing dial is provided for catching all threads without reversing the lead screw.

The heavy bed type taper attachment is designed for the heaviest taper turning and boring. It is mounted on a substantial bracket carried on heavy shears on the back of the bed and can be moved to any position along it. The taper guide bar, adjusted by a set over knob, is clamped in position by heavy bolts on each end. Should geared motor drive be desired for this lathe, the motor can be mounted on top of the head stock.



Le Blond Heavy Duty Lathe of Modern Design, Made in 25-In. and 27-In. Sizes

Gantry Crane for Handling Heavy Freight

AN electric gantry crane has been erected by the Niles-Bement-Pond Company in a busy freight yard near New York, as shown in the illustrations. This crane, embodying modern features of construction throughout, covers three tracks with two driveways, approachable from either direction, with trackage space for 15 cars at the crane. With a lifting capacity of 40 tons, the crane furnishes ample facilities for handling heavy freight, such as structural iron, building materials, machinery, boilers, steel freight containers, transformers, etc. An auxiliary hoist is provided, having 10 tons capacity.

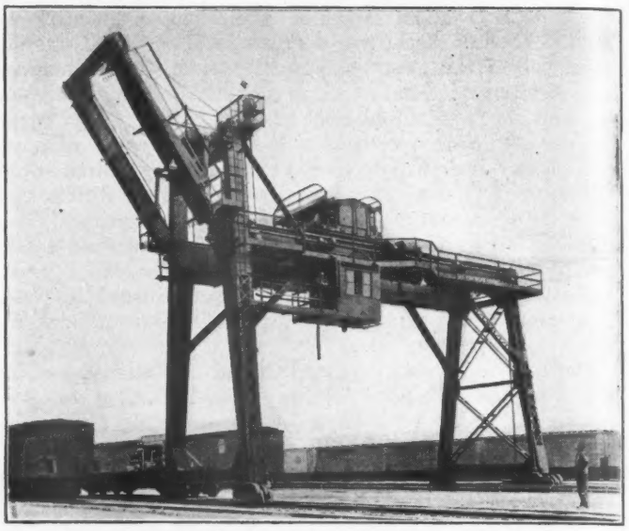
The span, center to center of the runway rails, is 49 ft. 3 in. With the cantilever extension at one end, the effective reach of the main hoist is increased 19 ft. 6 in. and the effective reach of the auxiliary hoist 21 ft. 11 in. The lift of the hook above the runway rails is 23 ft. The main and auxiliary hoist motors are each 50 hp. The trolley and bridge motors are 10 and 50 hp. respectively. The speeds with

maximum full load are: Main hoist, 10 ft. per min.; auxiliary hoist, 40 ft. per min.; trolley, 100 ft. per min., and bridge, 80 ft. per min.

The cantilever extension is of the elevating type, being motor-operated from the cage, and is readily elevated to clear any obstruction. Platforms are furnished on both girders running the entire length, including the cantilever extension. A platform is also placed at the top of the shear legs for access to the cantilever elevating mechanism and one on each side of the trolley, which is enclosed for outside service, as is also the cage. The top of the trolley housing is arranged so that any part can be opened on hinged joints, allowing easy access to the trolley mechanism for oiling, etc., or the entire house can be easily removed. The cross platforms are easily lowered on hinged joints, allowing unobstructed access to main and auxiliary hoist drums and gears.

The trolley frame is a self-contained built-up steel structure, with all the mechanism and motors mounted. The trolley is designed to incorporate such improved features of construction as complete lubrication, large wearing surfaces, ample strength and rigidity, self-contained units, easy accessibility and easy handling. The cage is of plate steel construction, special provision being made for mounting the controlling apparatus with concealed wiring. The back of the switchboard is reached through large doors, which, when opened, expose the entire board, allowing ready access to all wiring connections. The crane travels on eight wheels, four at each end, two wheels at each end being driven through carefully guarded gearing.

New 40-Ton Niles Gantry Crane Unloading Container Car Section



Gantry Crane with Cantilever Extension Placed in Raised Position

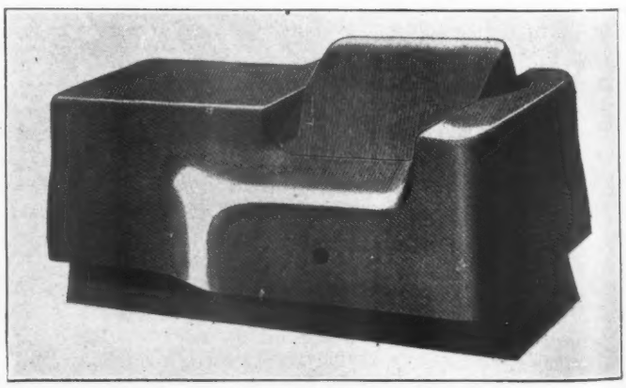
The installation of cranes of this type insures the prompt unloading and placing on trucks of all classes of heavy freight from any one of 15 cars available in the shortest possible space of time, thereby solving in a large measure freight congestion at terminal warehouses. There is an important saving of time and cost in handling heavy freight, and in addition it is moved more promptly to the consignee's premises.

Combination Hammer Die for Drawing Tapers

A COMBINATION hammer die for drawing tapers has been brought out by Beaudry & Co., Inc., Boston, Mass. This die can be furnished for any make or size of trip, air or steam hammer and by its use one man can in one heat draw almost any taper that can be handled under a hammer. As will be seen from the illustration, one end is provided with a tilting face so supported that it moves freely on a fixed axis, and the operator, by merely shifting the position or angle of the work and striking a light blow, automatically adjusts this tilting face to any desired angular position with relation to the top hammer die. Thus any desired taper can be given the work and any shaped piece can be completely finished and smoothed up, point and all, without subsequent hand finish.

Any scale falling between the tilting face and die holder is worked into a pit through grooves and forced out through a hole in each side of the die holder so that the tilting face works freely at all times. The fixed plain part of the die face can be used for general forging the same as any ordinary die. The die holder is cast of gun iron, while the tilting face is forged from 60 point carbon steel.

The die should prove extremely valuable for such work as forging flat, cape, diamond point and track chisels, calking tools, railroad spikes, slice bars, drift pins, brake levers, drift pins, wrenches, wedges, shims, keys, gibs and other similar parts.



Beaudry Combination Taper Hammer Drawing Die

GENERAL NEWS

The Norfolk & Western announces that an agreement has been completed with the newly formed association of its shop employees.

A bill to abolish the Railroad Labor Board by repealing sections 300 to 316 of the Transportation Act was introduced in the Senate on December 16 by Senator King of Utah.

Examiners Borland and Mullen, of the Interstate Commerce Commission, have concluded hearings in the general air brake investigation and briefs are to be filed by February 10.

Employees of the Chesapeake & Ohio, to the number of about 600, are to receive bonuses, a fixed sum for each day, for their voluntary service in doing emergency work during the shopmen's strike of last summer.

The Northern Pacific Shop Workers' Association is the latest addition to the ranks of the "company unions" not allied with National organizations. The new union is reported to have agreed with the company on wage scales and working conditions.

Renewed complaint about the condition of railroad equipment as a result of the shop strike was made to President Harding on November 25 by William H. Johnston, president of the International Association of Machinists, and B. M. Jewell, president of the Railway Employees Department of the American Federation of Labor. They also protested that several railroads were still violating orders of the Labor Board regarding contracting shop work.

The Transportation Brotherhoods' National Bank opened for business at Minneapolis, Minn., on December 19. This bank is owned by members of the brotherhoods of railroad enginemen and trainmen and is the sixth bank in the United States owned and operated by members of railroad labor unions. The president of the bank is Warren S. Stone, chief of the locomotive engineers, and the executive vice-president is W. P. Kennedy, general chairman, on the Chicago, Milwaukee & St. Paul Railway of the Brotherhood of Railroad Trainmen.

Employees of the Pennsylvania Railroad have bought, through the Mutual Beneficial Association, 27,000 shares of the stock of the railroad company, and about 1,500 shares were thus bought by employees during one week recently. J. K. Linn, treasurer of the Mutual Beneficial Association, Philadelphia, through whom the purchases are made, says that he recently received from one limited territory nearly 1,000 names of employees desiring to buy stock, most of them ordering a single share each. The stock is bought in the open market and the Mutual Beneficial Association keeps the shares for a time so as to allow the buyers to pay in instalments.

Senator G. W. Pepper, of Pennsylvania, to whom the representatives of the American Federation of Labor, speaking for former Pennsylvania Railroad shopmen, have appealed for aid, recently had a long conference with Vice-president W. W. Atterbury, and on Monday, November 27, at the invitation of General Atterbury, conferred at his office in Philadelphia with chairmen of the new associations of shopmen which have been organized since the strike, representatives of the former shopmen also taking part. This tripartite conference, after three hours' deliberation, was adjourned to a date to be selected by Senator Pepper. Reporting this conference, General Atterbury reiterates the determination of the railroad company to continue its present arrangement with its shopmen, unless the shopmen themselves desire a change; and says that he asked their representatives to confer with the Senator because, "I simply wanted them to share with me the burden of convincing people that what we have jointly set up on this railroad is fair and mutually satisfactory."

St. Louis Southwestern to Spend $5,000,000

The St. Louis-Southwestern has announced a $5,000,000 improvement program, including the purchase of 15 locomotives, 500 box cars, 500 automobile cars and 200 convertible cars; also, the conversion of locomotives used in Texas from coal to oil burners.

M. & N. A. Strikers Lose All Rights

Former employees of the Missouri & North Arkansas who went on strike about two months ago following their refusal to accept the wage offered by the road under the decision of the Labor Board, have lost all rights as employees of the road, according to a ruling of the Federal Court at Harrison, Ark., in which the temporary injunction against picketing was made permanent. All relationship that the former employees may have sustained to the company has ceased, according to the decision. The temporary injunction which is now made permanent was issued in July, and covered all the road's property in Arkansas.

Wage Statistics for September—Over $3,000,000 in Bonuses

The total number of employees reported by Class I railroads for the month of September, 1922, was 1,708,591, an increase of 114,517, or 7.2 per cent, over the preceding month, according to the monthly statistical bulletin issued by the Interstate Commerce Commission. The total compensation was $238,735,394, an increase of $13,758,750, or 6.1 per cent. The largest increase in employment appears in the maintenance of equipment and stores group, which was 96,505. The total number of employees falling within that group was 410,278, or 85 per cent of the average number employed during the 12 months preceding the strike. The number of persons employed as machinists, blacksmiths, or boilermakers was 69 per cent of the average for the year ended June 30, 1922.

As in August, the overtime made by shop employees was abnormally heavy, representing 25.57 per cent of their total compensation. In June, 1922, or the month just prior to the strike, this percentage was 2.62.

Reports from 181 roads employing 98 per cent of the total number of employees indicate that during the month the employees received bonuses amounting to $3,689,907 for loyal service performed during the strike, which amount is not included in this summary.

"Boring From Within"

Plans for amalgamating the 16 existing railroad labor organizations were discussed at a three-day convention at Chicago, which ended on December 11. A manifesto was adopted and a committee of 50 appointed to carry on the work advocated at this meeting. Reports indicate that of the 360 persons present the majority were former shop employees who are still on strike.

The leaders of the larger railway labor organizations did not participate in this meeting and several of them warned the members of their organizations not to attend. The presence of William Z. Foster and other advocates of the "one big union" idea, indicated that the purpose of the convention was to perfect plans for "boring from within" the existing organizations in order to bring about their dissolution.

New Freight Cars in 1922

The railroads of the United States from January 1 to November 1, 1922, had 47,802 more new freight cars, either ordered and under construction, or installed in actual service, than during the entire year 1921, according to reports received by the Car Service Division A. R. A.; that is to say, a total of 117,238 cars. During the year 1921 the total was 69,436.

Of the total for 1922, 50,196 were box cars, of which, up to November 1, 19,352 had been installed. Coal cars ordered totaled 49,383, of which 26,812 were actually installed.

There was also an increase of 716 in the number of locomotives installed or on order. Locomotives installed up to November 1 totaled 866, while orders had been placed for 1,232, making a total of 2,098, as compared with 1,382 in the 12 months of 1921.

Power Press Code and Head and Eye Safety Code Approved by the A. E. S. C.

The frequency of two of the most serious and most common types of industrial accidents should be greatly reduced through the application of two safety codes which have just been approved by the American Engineering Standards Committee. The Safety Code for Power Presses, Foot and Hand Presses, which has been approved as "Tentative American Standard," is the first national safety code on this subject to be prepared in America. The Safety Code for the Protection of Heads and Eyes of Industrial Workers, which has now received the A. E. S. C. approval as "American Standard" had been approved by the committee some time ago as "Recommended American Practice."

The high speed punch or forming press is one of the most dangerous machines in industry. This code consists of two parts —the first part describing standard requirements and the second consisting of a discussion of press hazards and protective methods and devices.

A statement from the National Committee for the Prevention of Blindness calls attention to Dr. Earl B. Fowler's estimate that there are in the United States approximately 15,000 persons who have been blinded by industrial accidents and that this is almost 15 per cent of the blind population of the country. In one state alone, Pennsylvania, 652 industrial workers lost one eye each and 18 lost both eyes in accidents during a single year.

Because of this serious situation the U. S. Bureau of Standards with the co-operation of the War and Navy Departments began in 1918 the preparation of a head and eye safety code. Several years ago this code was submitted for the approval of the American Engineering Standards Committee and it has since then been the subject of investigation, criticism, and revision.

The subjects covered in the Head and Eye Safety Code are: Protectors for Chippers, Riveters, Caulkers, etc., Protectors for Scaling, Grinding, etc., Protectors for Exposure to Dust and Wind, etc., Protectors for Babbitting, etc., Protectors for Handling Corrosive Chemicals, Dipping, Brush Coatings, etc., Protectors for Sandblasting, Protectors for Exposure to Glare, Protectors for Oxy-Acetylene Welding, Furnace Work, etc., Protectors for Electric Arc Welding and Cutting, Operating Rules, and Tests for Frames and Glass.

Electrification—Installation and Operating Costs

Steam Road Electrification was the title of an address presented by A. H. Armstrong, chairman electrification committee, General Electric Company, before the New York Electrical Society on Tuesday, December 19, at the Engineering Societies' building in New York. Mr. Armstrong stated that the saving in coal effected by electric operation should offset the additional cost of the electrical equipment. Electrical operating facilities exclusive of locomotives, he stated, cost just about as much as the electric locomotives themselves, while steam locomotive operating facilities, not required when a road is electrified, cost about one-half as much as the locomotives. Electrification, he said, in a given case, should save about 20 per cent in operating costs as compared with steam, 12 per cent of which was effected by reduced maintenance costs.

Mr. Armstrong also elaborated upon the better known advantages of electric operation, such as increased track capacity, improved terminal facilities, improved operation, etc. He also pointed out the fact that the great majority of steam road terminals were of a necessity on the outskirts of cities, and he stated that electrified terminals centrally located would minimize truck competition.

French Railway Labor Act Revised

The bill providing for a revision of the working day on French railroads effects small economies in the operation of the roads, which are now working under a heavy deficit, according to Commerce Reports. A distinction is made between active labor and mere presence on the job. In the former class the 8-hour day still obtains, while in the latter the length of the day varies according to the nature of the work. Each employee must put in 2,504 hours of work a year, with extra pay for overtime. The indefinite nature of this provision for overtime payment is expected to neutralize the good features of the bill.

Allowance is made for a reduction of 30,000 in forces and a decrease of 250,000,000 francs in the annual pay roll, while the eight-hour day law increased the operating forces by 110,000 and the pay roll over 1,000,000,000 francs.

Short Line Association Establishes Purchasing Agency at Chicago

The Consolidated Purchasing Agency of the American Short Line Railroad Association, which was organized in June, 1921, with James W. Cain as manager of purchases, was removed from Washington to Chicago, on December 1, 1922, and is now located in the Railway Exchange building. This change was necessitated by the increased volume of business being handled by this department of the association, which can best be taken care of from a more central point. Chicago was chosen in order that the agency might be able to keep in constant contact with manufacturers and secure the best class of used cars and locomotives direct from the trunk lines.

The membership of the American Short Line Railroad Association consists of slightly less than 500 different railroads, which in combination represent over 25,000 miles of main line tracks and an investment of over $1,000,000,000. These roads vary from small logging lines a few miles in length up to interstate carriers of several hundred miles, and include Class 2 and Class 3 roads.

While the consolidated purchasing agency assumes no financial responsibility, being unincorporated and without working capital, it acts as an agency for combining the purchases of these different railroad companies and for negotiating prices on a volume basis instead of the retail basis on which the individual small railroad has heretofore purchased its supplies. There has been no attempt to cover all purchases, but instead the agency has proceeded conservatively and confined its efforts during the first year to those materials which were either standard or susceptible of standardization. For example, purchases of rails have been made in 500-ton lots and distributed to member lines in less than 500-ton shipments, which gave them the same advantage as the purchaser of 500 tons and over. Likewise, spikes and bolts are purchased in carload lots, and even though a small road may need only 25 kegs it derives the benefit of the carload price. Besides purchasing, the agency aids in the sale of materials which the short lines do not need and arranges the exchange of equipment among the roads. To expedite the work of the agency a department of new equipment and materials, one of second hand equipment and one of industrial development was formed.

During its existence the agency has proved its value to the short lines, not only in purchasing and exchanging, but in the selection of equipment best suited to the most efficient operation of these lines. As a result the scope of the organization has reached such proportions that it is necessary to develop a more extensive organization. Accordingly plans are being considered wherein three regional offices will be opened during this year, one in the east, one in the south and one on the Pacific coast, which will facilitate the distribution of materials shipped in carload lots and reconsigned.

After an investigation covering the greater part of a year, augmented by answers to questionnaires sent to all member lines throughout the United States and Canada, the consolidated purchasing agency made recommendations and placed orders for over a quarter of a million dollars' worth of gasoline railway motor car equipment, representing some 20 cars, which are showing excellent results on the different lines and which are replacing steam passenger trains.

Through the activities of the manager of purchases, a finance corporation is now being organized under direction of the association, whereby member lines and others may acquire motor car equipment under a lease purchase plan, making it possible for the equipment to pay for itself through the saving effected.

Work is also progressing satisfactorily in the direction of arranging for standard designs of cars and locomotives, whereby substantial economies may be effected. It will also be possible by using standard designs to arrange financing on a basis that could not be done where a variety of different designs were contemplated. Through the consolidation of the requirements of these lines, the quantity will be sufficient to justify liberal prices and terms.

Just as fast as these different problems are worked out, others will be taken up, such as combining the fuel requirements in different districts, grouping the insurance, and possibly evolving policies giving more complete coverage than heretofore; conver-

sion of coal burning equipment to oil, where the combined locomotives are sufficient to justify lower prices and enable financing of the equipment; and other such innovations which make for economy.

"Railway Engineering and Maintenance"

Effective January 1, 1923, the name of the Railway Maintenance Engineer will be changed to Railway Engineering and Maintenance. At the same time, the number of editorial pages will be increased to permit the inclusion of more information relative to the design, construction and maintenance of railway bridge, building and water service facilities.

Since the establishment of the Maintenance of Way section in the Railway Age in 1911 and its development into the Railway Maintenance Engineer in 1916, there has developed a closer contact between engineering and maintenance, until today they are merged on many railroads. This increasingly intimate relationship has been apparent in the Roadmasters' Association, the Bridge and Building Association and the American Railway Engineering Association. It has also been reflected in the editorial contents of the Railway Maintenance Engineer and its circle of readers, until today this paper is read by nearly every railway officer of technical or practical training in charge of the construction and maintenance of roadway and structures. The new name has been adopted in order to indicate more accurately the nature of the editorial contents and the character of the readers of this publication.

The additional attention which will be given to bridge, building and water service problems is a recognition of the increasing importance of these phases of railway construction and maintenance. By increasing the number of editorial pages these developments will be treated more adequately without detracting in any way from the space now devoted to the problems of track construction and maintenance, or eliminating any other features now appearing in the publication.

Petition in Court Against Railroad Labor Board

The Railway Service & Supply Corporation, which contracted with the Cleveland, Cincinnati, Chicago & St. Louis to repair freight cars and locomotives at the road's shops at Beech Grove, Ind., and Brightwood, Ind., has petitioned the Federal District Court of Chicago for a writ of certiorari in order to obtain a court ruling on the action of the Railroad Labor Board in declaring these contracts to be violations of the Transportation Act and of decisions of the Labor Board. Petitioner points out that under the contracts the road is saving from $115,000 to $125,000 annually on the repair of locomotives and approximately $11,000 a year on repair of cars. All of the legal arguments which have been advanced before the Board and directed against that body's right to rule against such contracts are cited, and petitioner avers that the Board's decision "unjustly and unlawfully interferes with and prejudices relations established by petitioner with its employees and the railway company" and "any unlawful interference [with these relations] will deprive the petitioner of the full benefit of time, efforts, industry and large sums of money expended in perfecting the efficiency of its organization employed by it in operating the shops, to the great and irretrievable loss and damage of the petitioner." The application also calls attention to the fact that if the Board's ruling is allowed to stand "petitioner has good reason to fear that the railway company will terminate the contract" and "it will deter other railroads from seeking the services of the petitioner and from entering into similar contracts, all to the petitioner's great and irreparable damage." The Board is charged with exceeding the authority conferred upon it by the Transportation Act, and with infringing upon the judicial power of the courts and the legislative powers of Congress. The fact that the contractor was not represented at or notified of the hearings in the case is cited by the petitioner as depriving it of its rights of property and contract.

Labor Board Decisions

PROOF OF AUTHORITY FOR REPRESENTATION REQUIRED.—On April 18, 1922, the chief executive of the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers claimed, before the Labor Board, that the organization represented a majority of the maintenance of way employees and railway shop laborers on the Wabash, Chester & Western. The railway contended that there was no controversy between it and its employees; that on that railroad there was no organization of the employees referred to and that the complainant organization did not represent anyone on that road; and it refused to deal with them. The Labor Board decided that the road should arrange to hold a conference with the representatives of the maintenance of way organization; and if they can produce evidence that the employees on this road have designated that organization to represent them, negotiations shall be conducted in an effort to agree upon rules and working conditions covering the employees involved.—*Decision No.* 1357.

PAYMENT FOR YARD CREWS HELPING TRAINS OUT OF TERMINALS.—Prior to April 1, 1920, yard crews were helping trains out of yards and beyond yard limit boards at various terminals on the Minneapolis & St. Louis as a part of their regular assignment, compensation therefor being covered by yard rates without arbitraries or special allowances. After that date yard crews were allowed a minimum of one hour at road rates of pay, in addition to the day's pay for yard service, for each time such service was required of them, in accordance with an interpretation of paragraph b, Article 20, of supplement 24 to General Order No. 27. After the receipt of decisions rendered by the Labor Board of Adjustment No. 1, indicating that no change in the manner of payment for such services was contemplated in paragraph b, of Article 20, this allowance was discontinued. Members of the trainmen's organization then appealed to the Labor Board, contending that this allowance should be continued. The Labor Board decided that paragraph b applied only when yard engineers assist trains beyond the switching limits.—*Decision No.* 1285.

ENGINE WATCHMEN ENTITLED TO MEAL PERIOD.—The Gulf Coast Lines employ three engine watchmen at Anchorage, La., each of which is assigned to work 8 hours a day, exclusive of the meal period, which makes a spread of 8 hr. and 20 min., from the time they report for duty until they are released. The employees contended that these men should be allowed 20 min. or more for a meal period without deduction in pay since they did not leave the premises of the road for lunch, nor neglect any of their duties; there was sufficient time in which to eat while waiting for steam or for an engine to fill with water or oil. They contended further that the carrier has no right to hold them on duty an extra 20 min., without extra compensation. The carrier contended that it was within its rights by arranging the shifts in this manner and requiring a 20-min. overlap. The Labor Board decided that in accordance with section a-2, Article V, of Decision No. 501, the employees should be granted a meal period not to exceed 20 min., without deduction in pay and being required to lap shifts or make up this time.—*Decision No.* 1345.

EXTENDED LEAVE OF ABSENCE SUSTAINED.—A bridge and building foreman on the Chicago, Indianapolis & Louisville was granted two months' leave of absence to serve as general chairman of the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers. At the end of this period he decided to retain this position permanently and the railway demoted him to carpenter, contending that an employee in a supervisory capacity should not act as general chairman representing the employees. He was further notified that if he expected to remain in the service of the carrier as a carpenter, he would have to work enough time to keep his name on the payroll. The employees appealed to the Labor Board, which decided that it has been a recognized and time-honored practice with practically all carriers having working agreements with their employees to grant leaves of absence (oftimes indefinite with full retention of seniority rights) to general chairmen representing large groups of employees in order that they might perform the duties incumbent upon that position. The Labor Board decided that the carrier was not justified in refusing this man further leave and free transportation and that he should be restored to the seniority roster in accordance with his standing prior to his demotion.—*Decision No.* 1342.

Supreme Court to Review Pennsylvania-Labor Board Case

The United States Supreme Court on November 20 granted a writ of certiorari on the application of the Pennsylvania Railroad providing for a review of the decision of the court of appeals in the controversy as to the authority of the Railroad Labor Board to issue orders governing the method of employee representation on committees formed for conferring with the management on questions pertaining to rules and working conditions.

Selection of Employee Representation.—In accordance with Decision No. 119, the Pere Marquette entered into negotiations with a committee representing the United Brotherhood of Carpenters and Joiners of America which was recognized by the carrier as the duly recognized representatives of the workmen in the bridge and building department. In these conferences certain artworking rules and agreements were agreed upon, while certain others were not agreed upon and were submitted to the Labor Board for decision. Later the road entered into negotiations with the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers, in the course of which a disagreement arose regarding the scope of the rules so negotiated. The Maintenance of Way Brotherhood contended that it represented all employees in the maintenance of way department, while the carrier took the position that the bridge and building employees were represented by another committee and should therefore be eliminated from the scope of the rules under consideration. Later the carrier placed in effect the provisions of Decision No. 501 for all employees referred to therein, including those of the bridge and building department, in lieu of the rules agreed upon in the conference with the committee of the United Brotherhood of Carpenters and Joiners of America. Representatives of the employees took the position that the road should not have applied Decision No. 501 to the employees in the bridge and building department in lieu of the rules that had been agreed upon. In its opinion the Labor Board took the position that it will not decide questions as to the jurisdiction of organizations nor as to representation of employees. It sustained the carrier in the application of Decision No. 501 to the employees of the bridge and building department and stated that the inclusion of these employees shall not preclude them from selecting representatives of their own choosing.—*Decision No.* 1358.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. F. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamilton Ave., Chicago.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

Division VI—Purchases and Stores.—W. J. Farrell, 30 Vesey St., New York. Next meeting, Chicago, May 22, 1923.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Sectional meeting, February 8 and 9, City Club, Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Next meeting January 9. A paper on Kiln Drying of Lumber will be presented by F. O. Forey, Chemical Engineer, Robert Hunt Company, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Next meeting January 11. The subject to be discussed will be More Tons per Mile and per Car; How the Mechanical Dept. Can Help the Operating Department Save Money. J. J. Bernet, President of the Nickel Plate will open the discussion. Annual reports; installation of officers.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabash Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting January 9. A paper entitled "Is the Steam Locomotive Out of Date?" will be presented by L. G. Coleman, assistant general manager in charge of mechanical department, Boston & Maine.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Fruenthal, Union Station, St. Louis, Mo.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall 605 North Michigan Ave., Chicago.

SUPPLY TRADE NOTES

Irene P. Schofield, secretary, Universal Boring Machine Company, Hudson, Mass., died on December 3.

R. C. Jerome, vice-president and general manager of the Jerome-Edwards Metallic Packing Company, Chicago, has left the service of that organization.

F. W. Doty, Pacific Coast representative of the railroad and government department of Johns-Manville, Incorporated, New York, died at San Francisco on November 9.

The Willamette Iron & Steel Works, Portland, Ore., has begun the manufacture of gear type locomotives designed for use on logging railways. The company expects to build one locomotive a month.

The Gibb Instrument Co., Detroit, Mich., makers of electric welding equipment, has removed its plant and offices to Bay City, Mich. The purpose of this move is to provide increased manufacturing facilities.

R. M. Chissom, formerly chief clerk to the purchasing agent of the Chicago, Indianapolis & Louisville at Chicago, has been appointed special representative in the railroad department of the Lehon Company, Chicago.

D. S. Hutchcraft, formerly vice-president of the Indiana Air Pump Company, Indianapolis, Ind., has been appointed district manager in charge of the Chicago Pneumatic Tool Company's recently established branch office at Tulsa, Okla.

A. P. Dennis, who has been officially connected with the Standard Coupler Company, New York, since its organization, has resigned as vice-president and treasurer. E. F. Pride, secretary and assistant treasurer has been elected treasurer and C. T. Lynch has been elected secretary.

The Ingersoll-Rand Company and the A. S. Cameron Steam Pump Works, New York, have opened a branch office at 718 Ellicott Square building, Buffalo, N. Y. This new office is equipped to render full service to those interested in the numerous products manufactured by these companies.

Ray G. White, formerly Chicago branch manager of B. M. Jones & Co., Inc., has recently been appointed eastern railway sales agent for the McInnes Steel Company, Ltd., Corry, Pa., manufacturers of hammered crucible tool steels. Mr. White has opened up a temporary office at 56 Murray street, New York City.

The Minnesota Supply Company with offices in the Pioneer building, St. Paul, Minn., has been appointed northwestern representative for the Flannery Bolt Company, Pittsburgh, Pa. Blake C. Hopper, formerly with the American Steel Foundries, has been elected secretary-treasurer of the Minnesota Supply Company.

B. H. Tripp, formerly San Francisco manager of the Chicago Pneumatic Tool Co., has associated himself with F. C. Severin, formerly of Niles-Bement-Pond Company and Betts Machine Company in the sale of new and used machinery, with offices at 2220 Chestnut street, Philadelphia, Pa., and 25 Church street, New York City, under the name of Severin-Tripp Machinery Company.

The General Electric Company, Schenectady, N. Y., has set aside a fund of $400,000, the income from which will be available for encouraging and rewarding service in the electrical field by giving prizes to its employees. As an expression of appreciation to Charles A. Coffin, who retired in May, 1922, from the active leadership of the General Electric Company, the board of directors named it the Charles A. Coffin Foundation.

Alfred B. Carhart has resigned as vice-president and sales manager of the Crosby Steam Gage & Valve Company, to become president and general manager of the Precision Instrument Company, Inc., Newark, N. J. Mr. Carhart was for more than ten years works manager of the Crosby factory. He is a mechanical and electrical engineer and a graduate of Princeton

University. The Precision Instrument Company, Inc., has acquired control of the Precision Instrument Company, of Newark, N. J., and the present executive officers will retain their connection with the company. The company's New York City office will be at 114 Liberty street, and the factory will later be moved to New York.

J. J. McCarthy, treasurer and chairman of the board of directors of the Chicago-Cleveland Car Roofing Company, Chicago, died in Chicago from pneumonia on November 25. Mr. McCarthy was born at Burlington, Vt., on April 8, 1842, and moved to Chicago with his parents in 1845. His first railway experience was acquired with the Chicago & North Western in 1855. He was engaged in the banking business from 1856 to 1881 in Chicago, being associated with the Tinkeham Banking Company, George C. Smith & Co. and the Bank of Montreal, consecutively. During the Civil War he was in the service of the Army of the Potomac in the Quartermaster's Corps, being stationed at Harper's Ferry. In 1881, he organized the Chicago Car Roofing Company, which later became the Chicago-Cleveland Car Roofing Company. At the time of the Chicago fire, when the currency of the banks of that city could not be reached because of the fire, Mr. McCarthy went to New York and secured the first currency that was put into circulation immediately following the fire. Mr. McCarthy was said to be one of the two oldest residents of Chicago.

J. J. McCarthy

Peter A. Frasse & Co., Inc., New York City, has been appointed exclusive eastern distributor for the electric carbon, alloy and tool steels in bars, billets and die blocks manufactured by the Sizer Steel Corporation with plants at Buffalo, N. Y., and Solvay (Syracuse) N. Y., combined with the equipment of the Frasse Steel Works, Inc., Hartford, Conn., for cold finishing and heat treating. The Frasse Steel Works has been appointed the exclusive New England distributor for the Sizer Steel Corporation.

The Reed-Prentice Company, Worcester, Mass, has purchased outright the good will, business and certain assets of the Becker Milling Machine Company, Hyde Park, Mass., and the Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., and will manufacture the products of these two companies henceforth in its own plant at Worcester. The products will carry their former names, but the manufacturing will be all concentrated in the Reed-Prentice plant and the selling will be done by their present, and enlarged, sales force.

E. T. Fishwick, formerly sales manager of the Worthington Pump & Machinery Corporation, New York, has been elected vice-president in charge of sales to succeed F. H. Jones, resigned. William Goodman, assistant to vice-president, has been elected vice-president in charge of engineering and manufacturing to succeed J. E. Sague, resigned. Both Mr. Jones and Mr. Sague will remain with the corporation in a consulting capacity. James C. Barnaby, plant engineer of the Staten Island Shipbuilding Company, is now in charge of certain engineering work in the Diesel oil engine division of the Worthington Pump & Machinery Corporation.

E. D. Lynch, of the railway department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been transferred to the New Haven, Conn., office, to fill the vacany made by J. P. Alexander's removal to the Boston, Mass., office. R. W. Everson, sales manager of the Mexican branch of the Westinghouse Electric International Company, has been appointed district manager of the Atlanta, Ga., office of the Westinghouse Lamp Company, to succeed Julien Binford, Jr., resigned. A. G. Crocker has been appointed special power representative in the Detroit, Mich., office of the Westinghouse Electric & Manufacturing Company.

Herbert H. Hewitt, president of the Hewitt Rubber Company, Buffalo, N. Y.; the Magnus Company, Inc., New York; the Reading Car Wheel Company, Reading, Pa., and the St. Thomas Brass Company, St. Thomas, Ont., died at his home in Buffalo on December 19. Mr. Hewitt had been in poor health for two years. He was born on January 19, 1855, at Detroit, Mich., and entered the employ of the Pullman Company when he was about 20 years old and later became manager of that company. He subsequently went to Buffalo where he established the Buffalo Brass Company and the Union Car Works. The latter company later became the Buffalo Car Works of the American Car & Foundry Company. Mr. Hewitt was the inventor of several railroad appliances and served as president of the Magnus Company since its organization in 1899.

Frank N. Phelps was recently placed in charge of railroad sales of Baker industrial tractors and trucks, manufactured by the Baker R & L Company, Cleveland, Ohio. Mr. Phelps was born at Boston, Mass., on December 14, 1878. He received a mechanical engineering education at Massachusetts Institute of Technology and has been identified with the electric vehicle industry since 1911, when he took over the sale of Baker road trucks in New England. Mr. Phelps now becomes special railroad representative of the same company as noted above.

F. N. Phelps

Daniel M. Brady Honored

The directors of the Brady Brass Company, New York, tendered a luncheon at the India House, New York, on December 6, in honor of their president, Daniel M. Brady. The dinner was given in recognition of the fact that he has just completed a half century of service in the railway industry and two score years in the metal trade. There were a large number of guests, all business friends of Mr. Brady. Hon. Morgan J. O'Brien presided as toastmaster and addresses were made by Henry A. Bishop of Bridgeport, Conn.; John F. Fowles, vice-president of W. R. Grace & Co., and C. S. Trench, editor of the American Metal Market. Mr. Bishop made a presentation speech, Mr. Brady being the recipient of a gold watch, suitably engraved for the occasion, from the stockholders of the company.

Bethlehem Steel Corporation Absorbs the Midvale and the Cambria Companies

The board of directors of the Bethlehem Steel Corporation at a special meeting on November 24 authorized contracts for the purchase of the plants and other assets of the Midvale Steel & Ordnance Company and of the Cambria Steel Company, excepting the ordnance plant and other business located at Nicetown, Pa., and assets appurtenant thereto.

Through the acquisition of the properties of the Midvale and Cambria companies, the Bethlehem Company will acquire plants at Coatesville and Johnstown, Pa., and Wilmington, Del., and important developed iron ore properties in Michigan and Minnesota, as well as developed coal properties in Pennsylvania. It will also give to Bethlehem important lines of steel products which it does not now manufacture, such as steel freight and mine cars, steel wheels, boiler tubes, agricultural implement parts, etc. The Bethlehem Company's present annual ingot capacity of 4,800,000 tons will be increased to 7,600,000 tons by the Midvale-Cambria purchase.

Standard Stoker Company

The management of the Standard Stoker Company, Inc., New York, has been changed. Frank L. Connable, of New York, vice-president of E. I. du Pont de Nemours Company, who was president of the Standard Stoker Company, is now chairman of the board; W. A. Larner, of New York, vice-president of Peyton-du Pont Securities Company, is now president; Eugene du Pont, of Greenville, Del., a director of E. I. du Pont de Nemours, remains as vice-president of the Standard Stoker Company, and T. W. Keithley, of Wilmington, Del., formerly secretary, is now secretary and treasurer. The directors include F. L. Connable, W. C. Peyton, of New York, who is president of Peyton-du Pont Securities Company; W. A. Simonton, director of traffic of E. I. du Pont de Nemours Co., Wilmington, Del.; G. W. Keithley, Eugene du Pont and W. A. Larner. W. R. Williams, of Richmond, Va., has been appointed general manager with headquarters for the present at Erie, Pa., and Frank P. Roesch, who was western manager, has been appointed sales manager with headquarters at Chicago.

W. R. Williams

William R. Williams was born in Bristol, Va., on November 16, 1866, and was educated in the schools of Richmond, Va. He later, for ten years, attended Virginia Mechanics' Institute, a night school, part of the time teaching mathematics and drawing. At the age of 15 he entered the employment of the Old Dominion Iron & Steel Company at Belle Island, Richmond, serving for six years and when he left that company was chief of works' office. He later went to the Richmond Locomotive Works, and was secretary of the company when it was consolidated with the American Locomotive Company. He remained with the latter company two years as local purchasing agent—a total length of service with the locomotive companies of 18 years. In 1905, in co-operation with Joseph Bryan, formerly president of the Richmond Locomotive Company, he organized the Richmond Forgings Corporation. Mr. Williams served as vice-president of the new company until his recent appointment as general manager of the Standard Stoker Company. In July, 1920, he was appointed assistant secretary of war by President Wilson and served until March 4, 1921, when he was reappointed by President Harding and served for one month, returning to the Richmond Forgings Corporation.

Frank P. Roesch

Frank P. Roesch was born in Alsace, France, and came to this country immediately after the close of the Franco-Prussian War. After graduating from high school he entered the service of the Chicago, Rock Island & Pacific as machinist apprentice at Trenton, Mo., and while serving his apprenticeship studied mechanical engineering under the tuition of his father. Upon the completion of his apprenticeship he went west, working as a machinist in various shops until he resigned a foremanship to take a job as fireman, being later advanced to locomotive engineman. In 1899 he was promoted to traveling engineer on the Colorado & Southern and later was general traveling engineer of the Colorado & Southern System-Atchison, Topeka & Santa Fe, joint lines. In February, 1902, he was appointed master mechanic of the Chicago & Alton at Slater, Mo. He later served as general manager of the Hicks Locomotive & Car Works until the plant was sold in 1906, when he resigned to become master mechanic of the Southern Railway at Birmingham, Ala., and later was transferred to Spencer, N. C. In 1908 he was appointed master mechanic of the El Paso & Southwestern at Douglas, Ariz., where he remained until August, 1918, when he was appointed regional fuel supervisor, Northwest Region, U. S. R. A., and at the close of the railroad administration he became identified with the Standard Stoker Company, as its western manager.

Mr. Roesch has been a frequent contributor to the various railway technical journals since 1898. He is an authority on subjects pertaining to locomotive operation, combustion, etc., and is a past president of the Traveling Engineers' Association.

TRADE PUBLICATIONS

BOILER FEED WATER TREATMENT.—The Dearborn Chemical Company, Chicago, has issued a booklet entitled, "35 Years' Progress Boiled Down," in which the scientific treatment of waters for steam use are briefly summarized.

MISCELLANEOUS EQUIPMENT.—The Western Tool & Manufacturing Company, Springfield, Ohio, has issued catalogue No. 19 illustrating its line of expanding mandrels, tool holders, lathe dogs, C clamps, shop furniture, emery wheel dressers, and vises.

LOCOMOTIVE STARTER.—A booklet describing and illustrating the Street locomotive starter has recently been issued by Clement F. Street, Greenwich, Conn. Photographs and drawings are included showing the locomotive starter as applied to the trailer axle, and also diagrams showing the increase in starting tractive force obtained by the application of the starter.

COXE STOKER.—Bulletin CB1 and a small booklet entitled, "Service," have recently been issued by the Combustion Engineering Corporation, New York. The bulletin, covering the performance of the Coxe stoker on western and midwestern bituminous coals, contains a number of test reports, each of which is accompanied by corresponding curves; also a number of illustrations of successful installations.

TECHNICAL INFORMATION ON MICARTA GEARS.—In order to acquaint gear users with the advantages of Micarta gears, the Westinghouse Electric & Manufacturing Company has issued a 20-page booklet, entitled "Salient Facts on Silent Gears." The booklet describes the advantages of the use of Micarta gears and pinions and gives photographs and data describing some of their applications, tables of gear data, etc., enabling the gear user to judge whether or not they are applicable to his machinery.

SUBWAY AND ELEVATED SYSTEMS.—The principal characteristics of several great rapid transit systems from an electrical engineering viewpoint are presented in Bulletin 44018 issued by the General Electric Company. The facilities for power production, transformation, transmission and utilization are outlined briefly for each of the systems in the cities of Boston, Chicago, New York and Philadelphia.

The General Electric Company has taken a most important part in the manufacture of various types of apparatus for use on all of these systems. Exhaustive engineering studies and tests have been conducted by trained engineers to insure the selection of the proper equipment for the most reliable and efficient operation.

In the spring of 1893 the "Intramural Railway" was constructed at the World's Fair at Chicago and equipment was furnished by the General Electric Company for its operation. In 1895 the Metropolitan West Side Elevated Railway in Chicago was equipped on the same general plan and later in the year the Lake Street Elevated (Chicago) and Brooklyn Bridge (New York). In July 1897 a train of six motor cars was successfully operated in the presence of engineers of the South Side Elevated road and less than a year later 120 cars were in operation in Chicago, and the use of steam locomotives had been abandoned.

EQUIPMENT AND SHOPS

Locomotive Orders

THE CHICAGO, MILWAUKEE & ST. PAUL has ordered 75 2-8-2 type locomotives from the Baldwin Locomotive Works.

THE CENTRAL OF NEW JERSEY has ordered 10, 8-wheel switching locomotives from the American Locomotive Company.

THE LEHIGH VALLEY has ordered 30 locomotive tenders from the American Locomotive Company.

THE CHICAGO, BURLINGTON & QUINCY has ordered 50 2-8-2 type and 10 2-10-2 type locomotives from the Baldwin Locomotive Works.

THE NORTHERN PACIFIC has ordered 20 4-6-2 type, 25 2-8-2 type and 4 2-8-8-2 type locomotives from the American Locomotive Company.

THE MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE has ordered 5 4-6-2 type locomotives from the American Locomotive Company. These locomotives will have 25 in. by 26 in. cylinders and a total weight in working order of 269,000 lb.

THE DENVER & RIO GRANDE WESTERN has ordered 10 4-8-2 type and 15 Mallet type locomotives from the American Locomotive Company. The 4-8-2 will have 28 in. by 30 in. cylinders and a total weight in working order of 377,000 lb. Of the Mallets which are all of the 2-8-8-2 type, 10 will have 25 in. and 39 in. by 32 in. cylinders and a total weight in working order of 531,000 lb. and five will have a total weight in working order of 230,000 lb.

Passenger Car Orders

THE CHICAGO, ROCK ISLAND & PACIFIC has ordered 50, 70-ft. steel suburban cars from the Standard Steel Car Company.

THE PHILADELPHIA & READING has ordered 45 steel suburban passenger coaches and 5 steel suburban combination passenger and baggage cars from the Bethlehem Shipbuilding Corporation, Harlan Plant.

THE LONG ISLAND has ordered 40 motor cars, 20 electric trailer cars, 20 trailer coaches for steam suburban service, 10 coaches for steam service and 2 combination baggage and mail cars from the American Car & Foundry Company.

THE SOUTHERN PACIFIC will order 15 steel coaches for main line through service, 60 steel coaches for local service, 10 steel diners, 11 steel buffet baggage cars, 35 steel combination mail and baggage cars and 10 steel baggage cars.

THE NEW YORK CENTRAL has ordered 35, 70-ft. steel coaches with 4-wheel trucks from the Pullman Company; 20 combination passenger and baggage cars and 10 coaches from the Pressed Steel Car Company; 30 multiple unit steel passenger motor cars for suburban service, 20 coaches and 10 baggage cars from the Standard Steel Car Company and 40 baggage cars and 20 coaches from the American Car & Foundry Company.

Freight Car Orders

THE GULF REFINING COMPANY, Pittsburgh, Pa., has ordered 150 tank cars from the Standard Steel Car Company.

THE PERE MARQUETTE has ordered 500 hopper cars of 50 tons' capacity from the Ralston Steel Car Company and 1,500 box cars from the Western Steel Car & Foundry Company.

THE NORTHERN PACIFIC has ordered 1,000 box cars from the American Car & Foundry Company, 1,000 from the General American Car Company, and 1,000 from the Western Steel Car & Foundry Company.

THE ST. LOUIS SOUTHWESTERN has ordered 500 box cars from the American Car & Foundry Company, 500 automobile cars from the Mt. Vernon Car Company and 200 convertible cars from the Rogers Ballast Car Company.

THE UNION PACIFIC has ordered 1,000 refrigerator cars from the Pullman Company, 1,000 from the General American Car Company, 1,030 from the Pacific Car & Foundry Company, 1,500 from the Standard Steel Car Company, and 500 from the Mt. Vernon Car Company.

THE UNION TANK CAR COMPANY has ordered 1,000 tank cars of 10,000 gal. capacity from the Standard Steel Car Company, 1,000 from the American Car & Foundry Company, 500 from the General American Tank Car Corporation and 500 from the Cambria Steel Company.

THE CHICAGO, MILWAUKEE & ST. PAUL has placed orders with the Bettendorf Company for 3,000 gondola cars; the Western Steel Car & Foundry Company for 2,000 box and 1,000 gondola cars; the General American Car Company for 500 automobile cars and the Pullman Company for 1,000 gondola cars.

Machinery and Tools

THE NORFOLK & WESTERN has ordered from the Niles-Bement-Pond Company two right line 8-ft. radial drills.

THE PENNSYLVANIA has ordered from various builders about 35 tools, including lathes, grinders and horizontal borers.

THE MISSOURI, KANSAS & TEXAS has ordered a 10-ft. full pneumatic plate flanging clamp from the Niles-Bement-Pond Company.

THE SOUTHERN PACIFIC has ordered a Niles end-driven axle lathe, a piston rod grinder, and a quartering machine from the Niles-Bement-Pond Company.

Shops and Terminals

SOUTHERN PACIFIC.—This company contemplates the expenditure of $250,000 in shop buildings and machinery at El Paso, Tex.

ST. LOUIS-SAN FRANCISCO.—This company has awarded a contract for a 300-ton concrete coaling station at Ft. Smith, Ark., to Roberts & Schaefer Company, Chicago.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA.—This company has awarded a contract to the Ogle Construction Company, Chicago, for a 150-ton frame coaling station at Emerson, Neb.

MISSOURI PACIFIC.—This company has awarded a contract to Joseph E. Nelson & Sons, Chicago, for the construction of a one-story brick boiler house 47 ft. by 50 ft. at Coffeyville, Kan.

CHICAGO, BURLINGTON & QUINCY.—This company has awarded a contract to Joseph E. Nelson & Sons, Chicago, for the laying of 18,000 ft. of 16 in. pipe for its water treating plant at Galesburg, Ill.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS.—This company has awarded a contract to the Ogle Construction Company, Chicago, Ill., for the construction of a 400-ton, three track, concrete coaling station at Hillsboro, Ill.

GREAT NORTHERN.—This company has awarded a contract to the Roberts & Schaefer Company, Chicago, for the construction of a 500-ton fireproof, three track, automatic electric roller skip type locomotive coaling plant at Havre, Mont.

CHICAGO, ROCK ISLAND & PACIFIC.—This company has awarded a contract to the T. S. Leake Construction Company, Chicago, for a one-story addition, 40 ft. by 275 ft., to its machine shop and for the construction of a woodworking mill, 60 ft. by 128 ft., at Cedar Rapids, Iowa.

UNION PACIFIC.—This company has completed plans for the immediate construction of shops and yards at Los Angeles, Cal., to cost approximately $1,750,000. The new terminal will include an enginehouse, locomotive shops, freight car shops, coach shops, yards and related facilities.

ILLINOIS CENTRAL.—This company has awarded a contract to the Railroad Water & Coal Handling Company, Chicago, for a 300-ton coaling station at Macomb, Miss., and a contract to W. J. Zitterel & Co., Webster City, Iowa, for the construction of a water station at Calumet, Iowa.

CHICAGO, INDIANAPOLIS & LOUISVILLE.—This company has awarded a contract to the Ogle Construction Company, Chicago, for the rebuilding of a coaling station of 300 tons' capacity at South Hammond, Ind., to replace one which was recently destroyed by fire. The company also will construct a one-story frame shop 45 ft. by 200 ft., at Lafayette, Ind., to cost approximately $8,000, to replace one recently destroyed by fire.

NEW YORK, NEW HAVEN & HARTFORD.—This company will install a new turbine generator in its Cos Cob power station to take care of an increased load due to the placing in service of 12 new high speed passenger locomotives. The new generator is a 9,000 kw., single phase, 25-cycle unit.

UNION RAILROAD.—This company, which is an affiliated line of the United States Steel Corporation, has awarded a contract to the Roberts & Schaefer Company, engineers and contractors, Chicago, for a 100-ton capacity, two-track, reinforced concrete, automatic electric, Simplex roller skip type coaling and sanding plant, at Bessemer, Pa.

LOUISIANA & ARKANSAS.—This company, through its agents, Harrington, Howard & Ash, consulting engineers of Kansas City, Mo., has awarded a contract to the Herman & McCain Construction Company, Little Rock, Ark., for the building of a one story, brick and reinforced concrete locomotive shop to cost approximately $150,000, at Minden, La. The shops of the company were previously at Stamps, Ark.

PERSONAL MENTION

General

J. F. SHEAHAN has been appointed mechanical engineer of the Atlanta, Birmingham & Atlantic with headquarters at Atlanta, Ga.

A. W. KIRKLAND has been appointed superintendent of motive power of the Atlanta, Birmingham & Atlantic with headquarters at Fitzgerald, Ga.

H. L. HANNA has been appointed mechanical engineer of the New York, Chicago & St. Louis with headquarters at Cleveland, Ohio, succeeding T. A. Lawes, retired.

C. S. PATTON, superintendent of motive power (system) of the Seaboard Air Line, has been appointed superintendent of motive power, Northern district, with headquarters at Norfolk, Va.

G. T. DEPUE, mechanical superintendent of the Ohio region of the Erie, with headquarters at Youngstown, Ohio, has been transferred to the Chicago region, with headquarters at Chicago, Ill.

J. J. HANLIN, assistant superintendent motive power (system) of the Seaboard Air Line, has been appointed superintendent of motive power, Southern district, with headquarters at Savannah, Ga.

L. D. FREEMAN, assistant superintendent of motive power (system) of the Seaboard Air Line, has been appointed assistant to the manager of the mechanical department with headquarters at Portsmouth, Va. Master mechanics will hereafter report directly to the manager of the mechanical department on matters concerning classified repairs and to superintendents of motive power of their respective districts on other mechanical matters. Shop superintendents and other officers hitherto reporting to the superintendent of motive power (system) will report to the manager of the mechanical department.

Master Mechanics and Road Foremen

C. E. MCCLOSKEY has been appointed master mechanic of the Gulf Coast Lines, with headquarters at Kingsville, Tex.

E. M. BROCKMAYER has been promoted to road foreman of engines on the Detroit-Canadian division of the Pere Marquette with headquarters at Detroit, Mich.

W. H. GRAVES, locomotive engineer, has been promoted to road foreman of engines of the St. Louis Southwestern with headquarters at Pine Bluff, Ark., succeeding A. Townsend.

E. H. MCFADDEN, assistant superintendent of shops of the St. Louis Southwestern at Pine Bluff, Ark., has been promoted to master mechanic, with the same headquarters, succeeding J. W. Blakeburn, deceased.

D. DAVIS, assistant master mechanic of the Lehigh Valley with headquarters at Easton, Pa., has been promoted to master mechanic with headquarters at Coxton, Pa., succeeding W. B. Woolever, resigned.

C. H. HOLDREDGE, assistant general air brake inspector on the Southern Pacific, with headquarters at Los Angeles, Cal., has been promoted to district road foreman of engines, with headquarters at the same place, succeeding A. M. Meston, who has resigned.

W. S. TASKER, general foreman of shops on the Atchison, Topeka & Santa Fe at Clovis, N. M., has been promoted to master mechanic of the Panhandle division, with headquarters at Wellington, Kan., succeeding A. Dinan, retired on pension.

W. R. LANE has been appointed road foreman of engines of the Missouri division and L. L. LASSWELL of the Illinois division of the Atchison, Topeka & Santa Fe, with headquarters at Shopton, Iowa. C. C. REYNOLDS has been appointed district road foreman of engines of the Los Angeles division, with headquarters at Los Angeles, Cal. P. J. MALONEY has been appointed road foreman of engines of the first district of the Albuquerque division, with headquarters at Albuquerque, N. M., and the jurisdiction of W. Daze will be confined to the second district of the Albuquerque division with headquarters at Winslow, Ariz.

Shop and Enginehouse

A. TOWNSEND, road foreman of engines, of the St. Louis Southwestern at Pine Bluff, Ark., has been promoted to assistant superintendent of shops at the same point, succeeding E. H. McFadden.

D. A. CASSIDAY has been appointed day enginehouse foreman of the Baltimore & Ohio, with headquarters at Hazelton, Pa., succeeding A. McCormick, transferred. F. C. RYAN has been promoted to night enginehouse foreman at Hazelton, succeeding Mr. Cassiday, and C. STEPHENSON has been appointed boiler foreman, succeeding Mr. Ryan.

Obituary

W. QUEENAN, assistant superintendent of shops of the Chicago, Burlington & Quincy with headquarters at Aurora, Ill., died November 28 after a short illness.

JOHN T. CHAMBERLAIN, for a number of years master car builder of the Boston & Maine, died on December 12 at Medford, Massachusetts. Mr. Chamberlain was born at Eckington, England, on May 21, 1849, and came to this country with his parents shortly thereafter, locating at New York City. At the age of 18 he went to Kent, Ohio, to learn car building. In 1870 he entered the service of the Boston & Albany in its Allston (Boston) shops. In 1888 he left the Boston & Albany to go to Wichita, Kan., as superintendent of the Burton Stock Car Company. Two years later he returned to New England as master car builder of the Boston & Maine. He served in this position until the time of his retirement in 1907. Mr. Chamberlain was president of the Master Car Builders' Association in 1901.

J. T. Chamberlain

L. L. DAWSON, who was superintendent of motive power of the Ft. Worth & Denver City, with headquarters at Childress, Tex., until his retirement in 1918, died on December 11 at Champaign, Ill. He was born on February 5, 1863, in London, England. He came to the United States when a boy and entered railway service in February, 1880, as a machinist apprentice in the shops of the Illinois Central at Champaign, Ill. He received various promotions until he was made foreman of the shops at Champaign, in May, 1892. He was promoted to general foreman of shops at Louisville, Ky., in January, 1897, and a year later he was promoted to master mechanic at Memphis, Tenn. He held this position for several years until his appointment as superintendent of motive power of the Ft. Worth & Denver City, which position he held at the time of his retirement.